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THE WILEY FARM SERIES

EDITED BY

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SPECIALIST IN AGRICULTURAL EDUCATION, NEW YORK STATE DEPARTMENT OF EDUCATION

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SEED PRODUCTION AND MARKETING

THE WILEY FARM SERIES

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The Understanding and Application of the Laws of Genetics Have Enabled Present-day Plant Breeders to Achieve Remarkable Results in a Comparatively Short Time in Improving the Yielding Ability, Disease Resistance, and Market Qualities of Our Varieties of Field and Garden Crops. Such improved strains are the best foundation stocks of modern seed growers. The above photograph shows the late plant breeder, Frank A. Spragg, making plant selections on the breeding grounds of the Michigan Exp. Sta.

SEED PRODUCTION AND MARKETING

BY

JOSEPH F. COX

Professor of Farm Crops and Head of Farm Crops Section
Michigan State College and Experiment Station

AND

GEORGE E. STARR

Research Associate and Extension Specialist in Horticulture
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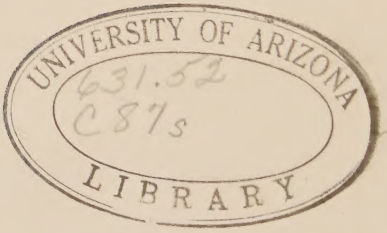

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To Dean Robert S. Shaw of the Michigan State College, in recognition of the inspiration and guidance of his friendly interest and broad knowledge of agriculture, this book is respectfully dedicated.

The Authors.

146670

PREFACE

Seed is of such primary importance to agriculture and the production and marketing of seed involve so large a capital investment and occupy the time and energies of so great a number of individuals.that the authors and editors have considered it a worthwhile venture to develop this pioneer seed book.

The successful methods and ideas of a large number of seed growers, plant breeders, wholesale seed dealers, and seed retailers are presented in this volume. Effort has been made to describe special cultural practices and equipment used by the growers of various seed crops in the effective production, harvesting, curing, and storing of seed; and by the seedsmen in preparing and marketing seed. The qualities of seed which influence productivity and adaptations of varieties are discussed fully from the standpoint of the crop grower.

In this primary attempt to treat fully with the production and marketing of seed of nearly all important crops in a single volume, the authors have been forced to confine their treatment to essential practices.

It is hoped that this volume will be of service to seed growers, seedsmen, farmers, vegetable growers, market gardeners, and as a reference and text book for teachers and students in agricultural colleges and high schools presenting vocational training in agriculture in regions where seed production is of importance.

Throughout the pages, acknowledgments are made for contributions from seed growers, agronomists, and seedsmen who have assisted materially in the development of this book. Chapter IX, on Kentucky Bluegrass Seed Production and Marketing, and the discussion of tobacco seed production on page 317 were prepared by Professor E. J. Kinney of the Univer-

sity of Kentucky. Chapter XI, on Cotton Seed Production, was written by Professor W. H. Darst of the University of North Carolina. To the many who have freely given of their time and experience, the authors express grateful appreciation.

The Editors and Authors.

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SEED PRODUCTION AND MARKETING

CHAPTER I

SEED PRODUCTION AND MARKETING

Human life and human progress depend, for continuance, upon the seed of cultivated plants conserved each year from harvest time to planting time.

The world's leading thinkers voice the fact that a highly developed agriculture is necessary for the maintenance and progress of civilization. No other factors are as important to the advancement of agriculture as the production and conservation for use of seed of high vitality of plant varieties of proven worth, and the creation of new and improved strains of crop and vegetable plants for the efficient feeding of domestic animals and the human race. The selection and care of seed constitute the most important of farm operations, and the seed industry is, in a sense, the most important of our basic industries.

Measured in dollars and cents, the combined annual value of field, garden truck and canning crops for the United States reaches a total of approximately ten billion dollars. From the standpoint of their importance in maintaining life and contributing to health and energy for the varied activities of our complex civilization, the value of these crops is beyond monetary computation.

Of all factors entering into the effective production of high-quality crop products, the seed planted is the most important. Ultimate yields depend upon the seed, soil, season, cultural

methods and control of insects and diseases. Upon the heredity and vitality of strains represented in the seed depend, most largely, the yielding ability, adaptation, uniformity of maturity, disease resistance and other characteristics determining the market value of the ultimate crop.

The skillful field and garden crop grower pays careful attention to the following factors in the choice of seed: adaptation,

FIG. 1.—High Quality Seed is Produced from an Improved Variety Kept Free of Weeds and Other Plant Mixtures. The above is a large onion-seed field in the Sacramento Valley, California.

breeding, vitality, purity, and freedom from diseases and weed seeds. The seedsman who fully understands the importance of these factors has a great advantage in most effectively serving his clientele.

Use adapted seed.—The proper adaptation to climatic and soil conditions and market demands is of prime importance in crop and seed choice. The broader field of crop adaptation is quite generally understood, but there is great need for a more general knowledge of the particular adaptations of strains or

varieties of individual crops to environmental conditions and special market demands. Only recently has the public become generally informed as to the unfitness of Italian red clover to planting in the Clover Belt of the United States. It is estimated that over 11,000,000 pounds of Italian red clover seed was imported into the United States from 1919 to 1924, directly from Italian ports, causing an estimated loss, due to clover failures from this seed, of over $25,000,000. Unadapted alfalfa seed produced in regions of mild climate has caused tremendous loss to planters in the Corn Belt and Northern States. Adapted seed from dependable distributors is now demanded by successful alfalfa growers in these regions.

Until the Michigan canners adopted an early-maturing strain of tomatoes, which would develop in a short season, the canning of tomatoes in that state was a very small and precarious industry.

The development and widespread planting of the stringless garden and canning bean made unprofitable the growing of stringy varieties of well-established types, and many growers who continued to plant old favorites of the stringy type suffered a needless loss which would have been avoided by the prompt adoption of the more desirable stringless varieties.

Great opportunities exist for the larger use of improved muskmelon varieties more pleasing to the palates of consumers than numerous varieties now grown and marketed. When the best-adapted muskmelon varieties are in common use, the ordering of a muskmelon will be no longer like buying a lottery ticket and the general use of muskmelons will be greatly expanded. The Emerald Gem muskmelon is a variety of highest quality and particularly adapted to use in the home garden, but too tender to remain in good condition when shipped over even comparatively short hauls. In general, western shippers of muskmelons find the Eden Gem, and Pollock types; and eastern shippers, the Bender, best adapted to shipping to market. These particular adaptations must be understood by the seed grower and distributor.

The development of the kitchenette nas sounded the death knell of the large Flat Dutch and Drumhead types of cabbage on most city markets and brought about a demand for smaller and more compact heads. The cabbage-seed grower must keep pace with such changes and anticipate them when possible.

Corn growers located on heavy late soils, or in localities

FIG. 2.—Alfalfa Seed Must be Distributed in Accordance with its Adaptation. Varieties adapted to the north in northern areas and southern varieties in southern states. The above shows Grimm alfalfa on the left, a good stand, and Arizona seed on the right, a failure replaced by dandelions after the first winter at the Michigan Exp. Sta. (C. R. Megee.)

where a short season prevails, must plant seed of corn varieties of sufficiently short season to mature.

There is a great loss each year due to lack of information on the adaptation of soybean varieties. For instance, the planting of the Mammoth Yellow varieties in northern regions results in crops which fail to mature, while growers of Ito San, Manchu, and other varieties adapted to northern localities

secure excellent yields under the same conditions. All such losses are greatly reduced in areas where seedsmen distribute varieties according to their adaptation.

Good seed must have high vitality.—A high percentage of germination is essential to effective production. Dead seed is, of course, worthless for planting.

The planting of seed of weak vitality results in unprofitable

FIG. 3.—It Costs Just as Much to Fit the Land and Cultivate a Poor Stand of Corn as a Good Stand. Planting seed of inferior germination results in fields like this one. (J. C. Allen.)

crops and is a great factor in producing economic loss. The fixed costs of plowing ground, fitting seed beds, cultivating, interest and depreciation on equipment, etc., make up the major part of the cost of crop production. These costs are nearly the same for a poor crop resulting from seed of inferior germination as for a profitable crop from good seed. Seed vitality and crop profits are closely correlated.

Low vitality in seed is caused most largely by exposure to

freezing or rain damage before or during harvest, poor curing resulting in a high moisture content, immaturity, injury from disease and insects, improper storage conditions, and deterioration due to age. Seed must be harvested at the right stage of maturity, cured properly, and stored under dry, well-ventilated conditions.

Seed of high germination shows, as a rule, good color, freedom from molds, disease and insect injury, and is generally plump and well matured. A knife inspection of the germ reveals a healthy color, usually similar to the color of a growing sprout. The odor of seed of high vitality is generally fresh and sweet, while seed of poor quality is often musty or sour. Seed of poor color or odor, or showing immaturity, should always be regarded with suspicion.

There is no sure way to tell whether the intangible spark of life is present in seed other than by testing the germination. Occasionally seed of apparently desirable physical characteristics will fail to germinate. A statement of a germination test made by an experienced tester, and the date of testing, should accompany the description of all seed purchased.

For testing the germination of large numbers of seed samples, specially manufactured seed germinators, with humidity and temperature electrically controlled, are used in seed-testing laboratories. Seed corn is usually tested for germination in such germinators or by the rag-doll method or the earth-box or sawdust-box method. Many handlers of vegetable crop seeds prefer to test the germination of vegetable seeds by the earth-box method, planting the seed at proper depth in earth carried in shallow boxes or trays, placed in a greenhouse where temperature and moisture conditions are under control.

For testing the germination of seed on the farm, the rag-doll, earth- or sawdust-box methods are commonly used. Practical tests may be easily made by placing 100 or more seeds on a moistened blotter in a pie pan, covering with another moistened blotter and with an inverted pie pan, and placing where the temperature approximates 70° F. A count of strongly germi-

nating sprouts, after four to eight days, makes it easily possible to determine the percentage of strong germination.

Farmers and gardeners will find the time spent in making germination tests on seed before planting most profitably employed.[1]

Secure seed of varieties improved by effective breeding methods.—The mind and hand of man from time immemorial

FIG. 4.—Testing Germination of Vegetable Seeds in Earth-filled Flats. Most seedsmen prefer to test vegetable seeds by the planting method. (Courtesy of Mr. Kirby White.)

have been employed in the development of the highly useful crop and garden plants possessed by the present generation. During comparatively recent times, plant improvement has changed from a slow haphazard process to the highly specialized technique of the modern plant breeder. New understanding

[1] See page 439, in Appendix, for instructions regarding the making and use of the rag-doll tester.

and application of the laws of genetics have enabled present-day plant breeders to achieve remarkable results in a comparatively short time in improving and standardizing strains of field and garden crops.

The most valuable seed is that resulting from the most skillful breeding. Seed of high-yielding varieties of most desirable qualities is worth many times the price of the seed of mediocre varieties, and seed from inferior or " scrub " varieties is generally worthless to the farmer or gardener.

FIG. 5.—A View of the Crops Breeding and Varietal Test Work of the Ohio Experiment Station at Wooster, Ohio. (Courtesy of Director C. G. Williams, Ohio Exp. Sta.)

Since it is usually impossible to tell definitely, by physical appearance, the strain or variety of a particular seed lot, reputable seed dealers are extremely careful in giving a true description of strains or varieties, and handling seed of various varieties so as to maintain identity from seed grower to purchaser. Seed of unknown origin is not handled by careful seedsmen, except under conditions of great scarcity of seed of known origin—and then with great reluctance.

The seed buyer should make every effort to secure seed

carrying the best heredity and should be certain of the source and truth of description of seed bought. The seed producer will find it highly advantageous to secure foundation stocks of the best available breeding for substantial increase and to master and employ effective methods of plant breeding to secure further improvement.

Many notable accomplishments in the development of more valuable varieties have been made in recent years, and the future for still further varietal improvement is exceedingly bright.

The modern plant breeder not only produces varieties of higher yielding ability and superior market qualities, but is able materially to offset losses from plant diseases and in certain instances from insects, by the development of resistant strains.

Some of the notable achievements of recent years are the development of the yellows-resistant cabbage by Jones of the Wisconsin Experiment Station, which brought back a large industry threatened by this disease; the Kanred wheat of the Kansas Experiment Station plant breeders, which is highly resistant to the black stem rust; the Alpha barley of the Cornell plant-breeding workers; the Robust bean developed by the late Professor F. A. Spragg at the Michigan Experiment Station, which is immune to the mosaic and quite resistant to blight and anthracnose and highly improved in yielding ability over other pea beans. The Markton variety of oat developed by the Oregon Experiment Station has a high degree of immunity to the smut of oats.

The application of effective methods of corn improvement to the seed stocks of sweet corn of a nationally known canning company by workers of the Michigan Experiment Station, resulted in a great improvement in yield, uniformity, and quality, thereby bettering the canned product and bringing increased profit to a large number of contract growers.

Pea canners find it of utmost importance that a strain of Alaska pea of high uniformity in maturing be distributed to growers. A very small percentage of immature peas of an

earlier strain will cause a very great loss due to the fact that these early peas will be hard at the time the main crop is ready for canning and the value of the whole pack will be seriously reduced. An appreciable mixture of later peas, while it may not injure the pack, may cause unpleasant relations between grower and canner, due to the grower's unwillingness to harvest when the majority of his peas are ready for delivery to the canning plant and the mixture of later peas is yet immature in the field. Recently great loss by canners and growers was suffered in an important Eastern canning state due to the state-wide distribution of an exceedingly ununiform supply of Alaskas.

The rust-resistant asparagus, developed by work of the United States Department of Agriculture, has conquered the only serious disease of this crop.

Many other outstanding plant-breeding achievements are noted throughout the pages of this book.

Good seed must have a high degree of purity.—The majority of the most troublesome weeds of America were introduced by the planting of crop seeds carrying noxious weed seeds. The planting of crop seed containing troublesome weeds may bring a pest to clean fields, which will cause years of effort and great expense in effecting control.

Weed seeds and dirt carried in seed supplies are paid for at seed prices. Good seed should be free from noxious weeds and should carry the smallest amount possible on a commercial scale of any kind of weed seed, other crop seed, or inert matter, such as dirt, chaff, broken seeds, etc.

The widespread prevalence of weeds in seed crops of the grasses and of clover, alfalfa, sweet clover, and many other forage crops, necessitates the thorough cleaning of seed of these crops, usually by use of elaborate cleaning machinery, before the seed is fit for planting. The increase of weeds in many areas makes seed production unprofitable, and causes the transference of the business of seed growing to other areas not so infested. Farms on which night-flowering catchfly is a pest are not suited to the production of alsike seed or clover or

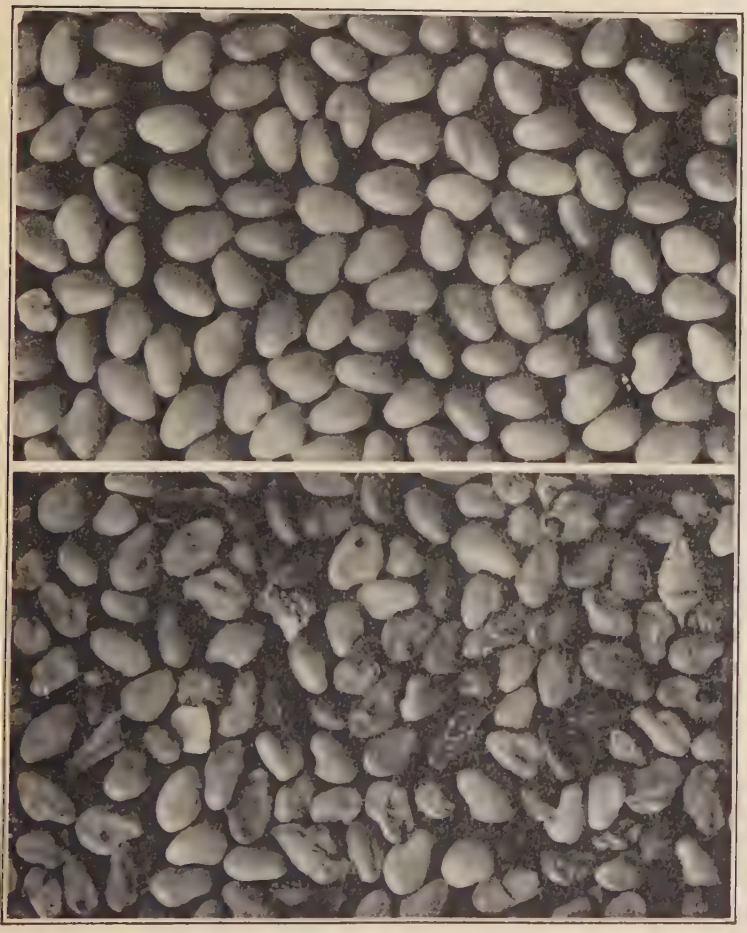

Fig. 6.—(*Left*) Clover Seed as it Comes from the Clover Huller Usually Carries a High Percentage of Dirt, Fragments of Stems, Weed Seed and Immature Seed. Such seed is not in condition for planting without being thoroughly cleaned. (*Right*) The Same Seed after thorough Cleaning with the Right Kind of Seed-cleaning Machinery Has a High Percentage of Purity. (Photo by R. H. Pettit, Michigan Exp. Sta.)

alfalfa seed until this pest is controlled. When buckhorn is allowed to increase rapidly in clover-seed-growing areas, clover-seed production rapidly ceases to be profitable. Sweet-clover seed produced on mustard-infested land has greatly impaired commercial value, owing to the difficulty of removing the mustard seed from the sweet-clover seed. Dodder in

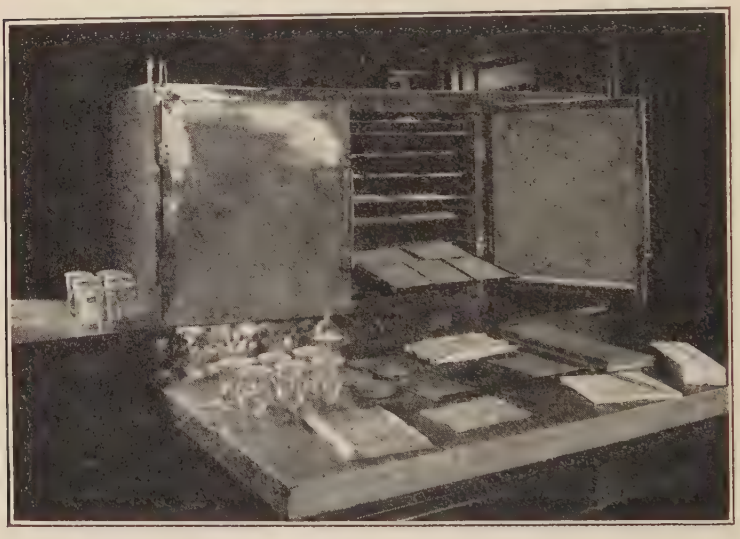

FIG. 7.—Apparatus Used in Germinating Seed. In background is germination chamber commonly used by the seed analyst. On table in foreground are shown seven types of setups used in germinating various kinds of seeds. (M. T. Munn, New York Exp. Sta.)

alfalfa and clover fields is a serious pest owing to difficulty in removing the dodder seed.

The control of weeds in the field is one of the greatest problems in effective seed production and the cleaning of seed so as to remove weed seeds is one of the most difficult and expensive processes in seed handling.

Nearly all states have seed laws forbidding the sale of seed carrying such weed seeds as Canada thistle, dodder, quack

grass seed and other noxious weeds, and requiring a statement of seed purity, percentage and character of weed seed present on tags accompanying field seeds offered for sale. State seed-testing laboratories are maintained and tests made of seed entering trade within the respective states by highly trained seed analysts, in order to form the basis for legal prosecution

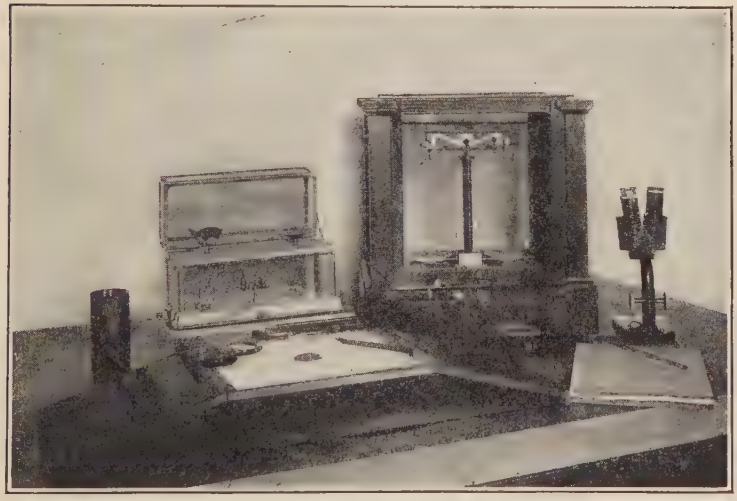

FIG. 8.—The Seed Analyst's Working Board and Equipment for Seed-purity Analysis. The test sample is weighed upon the balance at back of analyst's table, then is spread on working board and actual separations of clean seed, weed seeds, and other impurities, etc., are made and weighed on analytical balance at right. All seed impurities are identified and their names and prevalence indicated on the report sheet along with the percentage composition and other information. (M. T. Munn, New York Exp. Sta.)

of violators, and to call attention to sources of high-quality seed by periodic publication of results of official analyses of seed procured at many points with name of dealer responsible for distribution.

Mixtures of seed of other crops may, in many cases, greatly reduce the value of the crop. The presence of a relatively

small percentage of rye in wheat seriously effects the quality of the flour produced. Just after the World War, great loss was caused to American sugar beet growers due to the mixture of seed of stock beets of low sugar content in many lots of sugar-beet seed from European sources.

The similarity in appearance of cauliflower seed and cab-

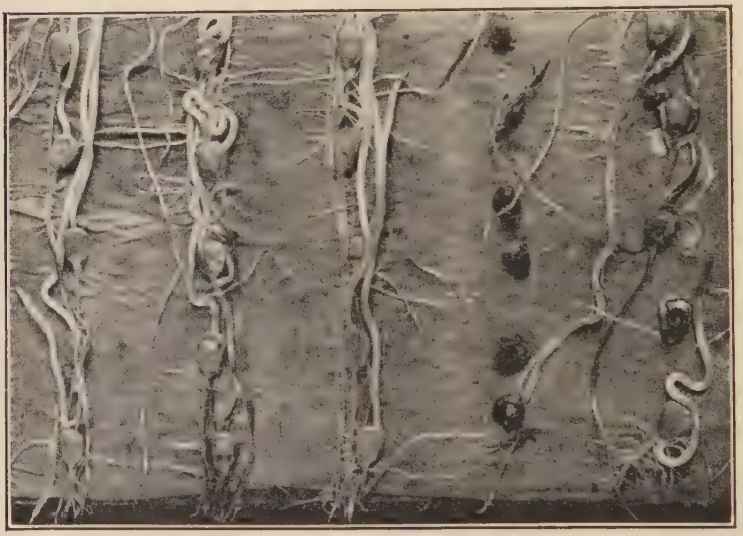

FIG. 9.—Many of the Most Serious Plant Diseases are Carried by the Seed. The above shows seedlings in a rag-doll germination test. Rows 1 and 3 are from healthy ears. Rows 2, 4, and 5 are from diseased ears which should be discarded and not used for seed. (Courtesy of Purdue University. Photo by J. C. Allen.)

bage seed causes occasional difficulty through seed becoming mixed.

Seed should be clean—free from seed-carried diseases and insects.—Many of the most serious plant diseases are carried by the seed. The root rot of corn, anthracnose of beans, peas, cucumbers and melons, smuts of small grains, ergot of rye, black rot and black leg of cabbage, fusarium wilt,

scab, late blight and black scurf of potatoes, rhizoctonia of sugar beets, and aschochæta of peas are outstanding examples of seed-borne diseases which annually cause great losses. The planting of clean seed and the use of proper seed treatments are necessary in controlling these diseases.

The planting of the seed of beans and peas carrying the bean or pea weevil, respectively, may result in serious losses.

The corn borer works in the ear as well as in the stalk of corn, and shipment of seed corn on the ear from infested areas is prohibited.

Insects that work in small grains and dried seeds of many field crops, such as the grain weevil, cadelle, angoumois moth, etc., greatly decrease the germination of seed and, therefore, injure seed quality.

Dependable seed growers and dealers render a great service to American agriculture and national welfare.—The good seed grower produces seed of high-yielding varieties, on which the purchaser can depend in producing a profitable crop of satisfactory market quality, provided, of course, that good cultural practices are employed and that the season is favorable.

The efficient modern seed grower possesses a knowledge of good breeding practices, secures good seed stocks, maintains improvement work, properly isolates breeding and seed production fields where necessary, and constantly strives to improve his basic seed stock. He knows and employs the best cultural practices and methods of controlling insects and diseases. Seed fields are kept free of weeds and plant mixtures by careful cultivation and rogueing. Great care is exercised in preventing crossing. His equipment consists of special harvesting machinery and specially constructed seed-curing and storage buildings.

Particular care is exercised in harvesting at the right time and in the right way to prevent injury to germination and to produce seed of acceptable appearance for marketing.

The efficient wholesale seed dealer who handles seed of numerous varieties in large quantities generally secures his

seed supplies by contracts with many growers, or from other reputable dealers. The best wholesalers are careful in furnishing seed stocks of highest grades obtainable to contract growers. Their fieldmen aid in maintaining these stocks at a high standard of purity by a series of inspections and rogueings at the

FIG. 10.—An Aeroplane View of an 850-acre Stock Seed Farm in Michigan Devoted to the Testing and Breeding of Garden, Truck, and Canning Crop Seeds. (Courtesy of D. M. Ferry Company.)

proper time. Trial grounds are important adjuncts to the seed business in order that old varieties may be constantly under test and new varieties given careful observation and their merits determined. Constant effort is made to reduce the number of varieties by eliminating the inferior and undesirable, and retaining the superior varieties.

The most efficient wholesale seedsmen are equipped with cleaning plants and warehouses, usually located in producing sections in the case of field-crop seed-handling. Seed is assembled from many growers and, immediately after harvest, cleaned by use of effective fanning mills and other seed-cleaning machinery specially adapted for separating and removing various weed seeds and other impurities. Efficient power seed-cleaning mills with complete equipment, separating weed-seed, dirt and light seed by air blast, screens, gravity, salt solution, and centrifugal force and other processes are part of the essential equipment of a modern seed-cleaning plant.

FIG. 11.—A Modern Seed-cleaning, Storing, and Shipping Plant. Cleaning and preparing seed, particularly vegetable and forage-crop seed, for the general seed trade may be compared in many respects to a highly specialized manufacturing process which develops a raw product into a finished material ready for use. (Courtesy of Northrup, King & Company.)

Buckhorn can only be removed from field-run clover seed by the use of special buckhorn cleaning machinery. The seed coat of buckhorn is mucilaginous when wet, and adheres to sawdust mixed with wet seed carrying buckhorn. The sawdust and adhering buckhorn is "scalped off" or removed with a scalping screen, and the clover seed dried. Another type of buckhorn cleaner works on the principle that buckhorn seed is retained on a rough canvas belt, over which the clover seed passes freely.

Centrifugal machines have been developed which handle clover, alfalfa and other small seeds suspended in salt solution of

proper saturation, removing seeds of varying specific gravity in a centrifuge. Gravity machines are employed in removing Russian thistle seed from alfalfa. These processes are costly in operation.

A new type of seed-cleaning machine utilizes the fact that seeds of various plants offer a varying resistance when forced through the air. Canvas catch pockets are arranged in line and a stream of seed is shot by air blast above the canvas pockets. Heavy, smooth, plump seeds drop into the farthest catch pockets while light seeds and angular seeds of greatest surface, and hence air resistance, are caught in the nearest containers.

Beet seed is cleaned of small sticks and dirt by passing over an inclined canvas belt which moves at slow speed. The dirt and sticks adhere to the belt and are carried over while the seed falls to the bottom. A somewhat similar process is used to remove seed of wild buckwheat from radish seed.

Seed beans and peas are cleaned over special mechanical pickers followed by hand picking, the beans or peas being carried on a slow-moving belt and diseased seed, immature seed, and otherwise unfit seed and trash being picked from the belt by girls and women.

Steam dryers equipped with blower fans are part of the necessary equipment of large seed handlers since much seed coming in from country points is too high in moisture to be safely stored and must be reduced to 15 per cent or less of moisture content for safe storage.

Automatic scales and bagging machinery for quick and accurate weighing and sacking are necessary in weighing and bagging lots when preparing for shipment. Automatic packet-filling machinery is necessary in preparing small packages of vegetable seeds for the retail market.

Most of the machinery above mentioned is expensive in cost and in operation and requires the employment of specially trained operators, and hence is not part of the equipment of the small seed grower.

Many field-seed crops, such as clover, alfalfa, and grass seed from areas infested with weeds, must be skillfully cleaned over the right machinery before the seed is fit for planting.

Alfalfa and sweet-clover seed are often improved in effective germination by the use of the scarifier, which thins and abrades the seed coats of hard seeds.

Seed of grasses, alfalfa, clover, sweet clover, and many other

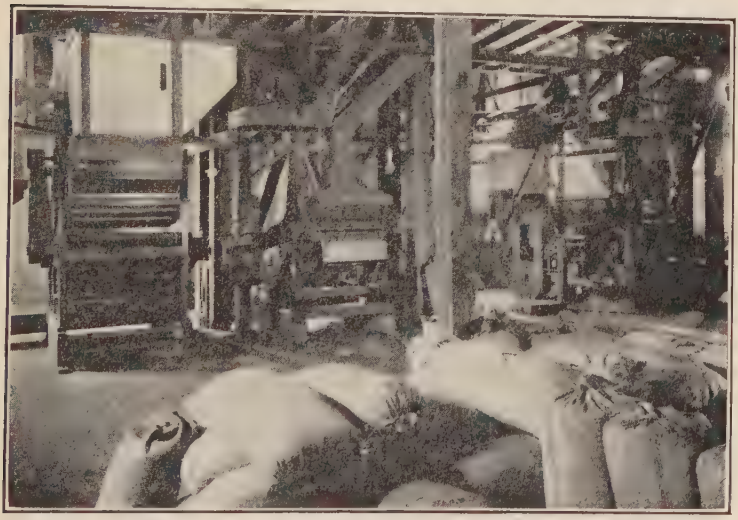

FIG. 12.—The Modern Seed House is Equipped with Effective Fanning Mills and Other Seed-cleaning Machinery, Scales, Automatic Baggers, and Labor-saving Seed Chutes and Elevators. Seed as it is assembled from many growers must be thoroughly cleaned. (Courtesy of *Seed Trade News.*)

crops, as it comes from the field, or "in the dirt" must be thoroughly processed.

Cleaning and preparing seed for market may be compared in many respects to a highly specialized manufacturing process which develops a raw product into a finished material ready for use. Specially trained men are necessary in the field and in the cleaning plant.

Lot records are carefully maintained so that the exact composition of large bulks can be traced to the many small lots often thrown together to secure a uniform bulk. Careful seed analyses and germination tests must be made of each lot and blends made in the preparation of the finished market product.

The dependable modern seedsman distributes seed of alfalfa, corn, soybeans, and other crops of varying adaptability according to the respective sectional adaptation of these crops.

Fig. 13.—A Well-equipped Retail Seed Store.
(Courtesy of *The Seed World.*)

The modern tendency is for seed catalogs representing the products of such seedsmen to confine all statements strictly to facts and to furnish accurate information regarding variety, adaptation, germination, and purity with each lot of seed.

The seed retailer who renders the greatest service carefully selects the best varieties for his class of trade, listing a comparatively small number of varieties of super-excellence rather than a full line containing many varieties from which his clientele will receive little profit and satisfaction.

The average purchaser of seed is frequently not fully posted

Two Effective Methods of Retailing Seeds.

FIG. 14.—The Packet-case System of the Commission Seed Trade. Cases filled with seed packets are placed with seed retailers in seed stores, hardware stores, grocery stores, or other stores handling seeds.

FIG. 15.—Shipment of Seed by Parcel Post on Mail Order has become of Great Importance in Seed Retailing.
(Photos by courtesy of *The Seed World.*)

as to the better strains and varieties and must look to his retailer to aid him in the selection of the best. Such retail service demands a connection with dependable wholesalers.

The seed dealer, wholesale or retail, must constantly consider seed in the light of its crop-producing power, and not simply as a commodity to be bought and sold at a profit, if he seeks to render the fullest service to his patrons. The seed dealer should be a true seedsman.

GENERAL INFORMATION

What is a seed?

A true seed consists of a small or embryonic plant containing food material within itself, or often imbedded in tissue containing a store of food material, and surrounded by a seed coat.[2]— The seeds of plants of the grass family (which includes wheat, oats, barley, rye, corn, and the smaller-growing forage, and tame and pasture grasses) are made up of the ***embryo***, commonly called the ***germ,*** the ***endosperm*** or surrounding food material, and the enveloping ***seed coat.*** The ***plumule***, or top part of the embryo, develops into the top growth and permanent root system of the plant; the ***radicle***, or lower part of the embryo, forms the ***temporary*** or ***seminal roots***, which function until permanent roots develop. The ***scutellum***, or ***cotyledon***, the part of the embryo next to the storage tissue or endosperm, through the secretion of enzymes, dissolves or "digests" the stored-up food material in the endosperm. These processes take place under the proper air conditions of moisture, heat, and light, and constitute ***germination.***

In seeds of legumes (such as beans, peas, alfalfa, clover seed, etc.), the two cotyledons make up the bulk of the seed within the seed coat. No endosperm is present. The plumule and radicle are found between the cotyledons on splitting the seed. In the process of germination, the radicle pushes down and forms the permanent root system. The stem por-

[2] Dr. E. A. Bessey, Dept. of Botany, Mich. State College.

tion of the plumule develops and pushes the two seed halves, or cotyledons, upward above the soil surface. The cotyledons, or seed leaves, give up their stored food and drop off, the plumule developing into the top growth. In the case of peas and Scarlet Runner beans, the cotyledons remain under the soil surface, the stem being pushed above ground.

The seeds of corn, wheat, oats, barley, rye, bluegrass, and all members of the grass family are ***monocotyledonous***, having but one cotyledon. The seeds of beans, peas, clover, alfalfa, and all other legumes have two cotyledons and are termed ***dicotyledonous.*** The seeds of certain non-legumes, such as squashes, pumpkins, cucumbers, and melons, are also dicotyledonous.

Seeds of the legumes that are pushed above ground in development must be planted on thoroughly surfaced seed

FIG. 16.—Seed Trier, or "Thief," Used in Taking Seed Samples from Bag at Various Places. (Courtesy of G. C. Edler, U. S. Dept. Agric.)

beds at comparatively shallow depths. As a class, the seeds of the monocotyledonous grains are planted somewhat deeper and will give more uniform stands under seed-bed conditions which would result in exceedingly ununiform stands of beans or of alfalfa.

Seeds of beets, mangels, and Swiss chard grow in clusters. What is commercially known as a beet seed is a collection of from two to six true seeds tightly bound together, each seed surrounded by a corky calyx. The so-called seed of the New Zealand spinach is a round, rough seed pod containing a number of true seeds.

In a broad sense a seed may be defined as "any propagative portion of a plant whether of true seeds and seed-like fruits, or of tubers, bulbs, etc." (Webster).

CHAPTER II

IMPROVING VARIETIES BY MODERN METHODS OF BREEDING

"Heredity is a property of all forms of life."—Donald Forsha Jones.

The degree of usefulness of present-day crops of field and garden has been achieved as a result of centuries of more or less

FIG. 17.—Cages Containing Selected Plants of Golden Plume Celery at Seed Farm of C. C. Morse & Co., California. The cloth-covered cages prevent cross-pollination and insure the production of pure strains. (Courtesy of *The Seed World.*)

haphazard selection and a comparatively few generations of scientific plant breeding. The application of modern methods

of plant improvement within recent years has resulted in marked betterment of yield, disease resistance, drought and frost resistance, market quality, adaptation, and other factors contributing toward the general usefulness of a large number of our leading crops. The opportunity for further improvement is greater at the present time than ever before, owing to the fact that applicable methods more certain of results are now available to the plant breeder and the informed seed grower, and the average planter of field and garden crops has become more generally informed in regard to the value of strains of superior heredity. There is an ever-increasing market demand for high-quality seed of improved varieties.

Fig. 18.—Pea Selections Growing in Greenhouse. The use of a greenhouse may often hasten the progress of plant-improvement work through selection or cross-pollination, as it enables the plant breeder to produce two generations in one year. (Courtesy of Dr. Wilber Brotherton and U. S. Dept. Agric.)

The matter of disease resistance in varieties received but little attention a few years ago, but the development of such outstanding improvements as the Kanred wheat of the Kansas Experiment Station, resistant to black stem rust; the Robust bean of the Michigan Experiment Station, resistant to mosaic; the smut-resistant Markton oat of the Washington Experiment Station; the Wells red kidney bean from Cornell Uni-

versity, which is resistant to anthracnose; the Wisconsin yellows-resistant cabbage from the Wisconsin Experiment Station; the Washington rust-resistant strain of asparagus from the Arlington Station of the United States Department of Agriculture; and many others have indicated a new field of great value and promise.

The betterment of yield and market quality are important factors in cheapening costs of production and improving marketing opportunities, thereby increasing profits per acre. The Burbank potato is estimated to have added $17,000,000 annually to the value of our potato crop due to its superiority in quality and yield.

Seed stocks of improved strains of numerous varieties of field and garden crops, from the hands of the nation's leading plant breeders, are available to the alert seed grower; and opportunities for further plant improvement exist for him, according to his keenness of observation and skill in selecting or hybridizing to secure improvement in varieties.

The following methods are employed in plant improvement:

1. Selecting promising types of self-pollinated plants. (Single plant selection.)
2. Selecting superior individuals of cross-pollinated plants and self-pollinating to reduce to pure lines and fix desired qualities.
3. Selecting best individuals from plants in which cross-pollination is obligatory either through self-sterility or due to the fact that they are dicœcious and restricting pollination to this group of plants alone.
4. Hybridizing or cross-pollinating strains of both normally self- and cross-pollinated plants to secure desirable types which may result, combining the good qualities of the parent plants.
5. Selecting superior individuals of either cross- or self-pollinated plants and planting selections together for increase. (Mass selection.)

6. In case of vegetatively propagated plants, selecting tubers, root cuttings or shoots, stolons or bulbs from desirable parent plants.

7. Maintaining testing plats to compare new selections of promise with strains of known habits of growth and value.

8. Isolating increase fields for multiplying cross-pollinated plants.

Selecting promising types of self-pollinated plants.—Wheat, oats, barley, vetch, beans, and field peas are examples of normally self-pollinated plants of field crops. Peas, beans, lima beans, tomatoes, peppers, and lettuce are normally self-pollinated vegetable crops. Occasional crossing in the field occurs with each of the above-listed field and garden crops.

Many useful varieties of self-pollinated plants have been developed by selecting a desirable plant in the field, reserving the seed for increase, and increasing by planting and harvesting separately.

The modern plant breeder, however, secures more certain results. He selects several hundred or more desirable plants from the field or selection bed, harvests each separately, using a readily cleaned hand-separator, then places the seed from each plant in a properly numbered envelope or small bag, and stores carefully in insect-proof containers until the next planting season.

Progeny rows of equal length are planted (usually in duplicate series) from the seed of each marked envelope, and marked with small stakes carrying the respective identification numbers. The growth of each progeny row is observed during the season, and proper notes taken. At harvest time, each row is harvested separately, the plants tied in bundles, marked with assigned numbers, cured, and threshed in a small separator. The seed from each progeny row is inspected and weighed and is placed in small bags carrying the respective identification numbers.

In the case of small grains, the seed from the progeny rows

that show the heaviest yield of grain of best market quality, and other desirable qualities such as stiffness of straw, maturity at right time, comparative absence of tendency to shatter, freedom from, or resistance to disease, etc., is reserved for planting the following season.

FIG. 19.—Breeding Disease-resistant Strains of Beans. The Seedling plants are inoculated with culture of Anthracnose. The resistant strains in center show no disease, the non-resistant strains at right are quick to show injury from disease. (Photo made by R. D. Rands at U. S. Dept. Agric. greenhouses, Arlington, Va.)

The next planting season, rod-rows (rows one rod long) are planted in series and properly numbered, usually from 2 to 4 replications being made of the desirable strains, the remaining seed being reserved in bags carrying the respective strain numbers. Careful field observations of resistance to disease, stiffness of straw, time of maturity, and other characteristics

are made and properly noted for the rod-rows of each strain. The rod rows are harvested, threshed, and weighed separately. The outstanding strain may be ascertained and the seed of all rod-rows of that number combined for increase the next year, or several seasons more may be given to further testing. For purposes of comparison, rod-rows of a standard variety of known yielding ability are usually included, from the second year on, as check plats for comparison.

When enough seed of the one or more strains selected as

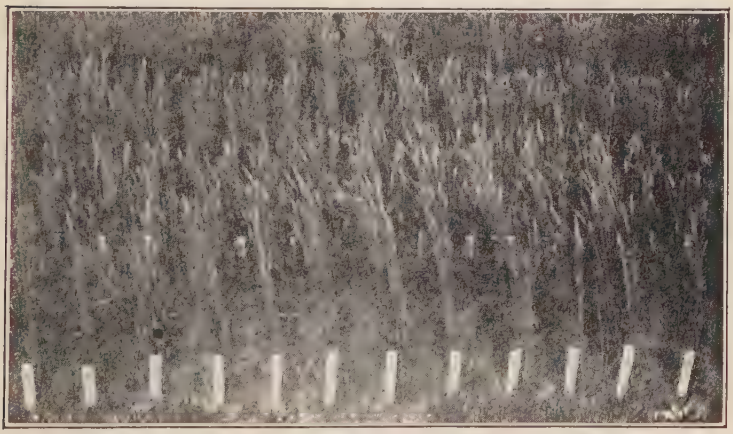

FIG. 20.—Rod-rows of Strain Selections of Wheat in Wheat-breeding Plats at the Michigan Experiment Station. (Courtesy of E. E. Down.)

superior is secured, it is planted in increase plats, and also in a varietal series including standard varieties of known worth, to prove its superiority. If the selected strain continues to demonstrate superior yielding ability, disease resistance, and other desirable qualities, the seed is increased to the point where enough is secured for extensive field planting. Since all the seed came, originally, from a single plant, the new variety is a "pure line" or "single strain." Before general distribution is made, regional varietal tests should be conducted on representative soil types, a standard variety of known value

being used as a check, and local varieties included for comparison.

The eventual distribution of the new strain should be in accordance with its proven yielding ability and adaptation under the soil and climatic conditions of various localities. Such work is now effectively conducted by the Bureau of Plant Industry, United States Department of Agriculture, and the experiment stations of nearly all states and Canadian provinces.

The Red Rock wheat of Michigan was developed originally by the late Plant Breeder, F. A. Spragg, from a single kernel of red wheat which occurred in a white wheat variety. This kernel was exceptionally large, and of an unusual translucence and hardness for a soft winter wheat kernel. It was carefully preserved and increased and, after comparison with other varieties, found desirable as a yielding and milling wheat and increased by seed growers of the Michigan Crop Improvement Association and generally distributed throughout Michigan on the more fertile wheat soils to which it was proven to be best adapted. This variety is now the leading red winter wheat of Michigan, being highly appreciated by millers as a superior local bread wheat because of its high gluten content as compared to other semi-hard winter wheats.

Selecting superior individuals of cross-pollinated plants, and self-pollinating to reduce to pure lines and fix desired qualities.—Corn, rye, timothy, the sorghums, and sugar beets are examples of normally cross-pollinated field crops. Of garden truck and canning crops, the following are outstanding examples of cross-pollinated plants: radishes, turnips, beets, carrots, onions, cucumbers, melons, and squashes.

Present-day corn breeders are getting exceedingly promising results by self-pollinating a large number of corn plants for several seasons to secure pure lines, testing the resulting ears in ear-row plats to observe yield, maturity and other qualities, reserving a numbered remnant of each selfed ear planted in the test.

The remnants of the best strains, as indicated by the ear-row test, are reserved for future planting and hybridization. The selfed ears of corn are usually of small size and insignificant in appearance, and when kernels from selfed ears are planted the resulting plants and ears do not compare, as a rule, to normally hybridized plants. Proper crosses made from the best strains, as shown in an ear-row test, often give surprising

FIG. 21.—Modern Corn Breeders are Securing Exceedingly Valuable Results by Self-pollinating Individual Corn Plants to Secure Pure Lines, Testing Resulting Ears in Ear-to row Test Plats, Increasing Desirable Remnants Separately and Recombining Desirable Lines for Extensive Field Planting. The above shows tassels and developing ears protected by paper bags. (Courtesy of Michigan Exp. Sta.)

results in yield increase, particularly the year following the season when the pure lines are hybridized. Such hybrids seemingly do not maintain their yielding ability but decrease in yield year after year, so that if this method of crossing a small number of pure strains is to be of practical value, elaborate breeding work by skillful plant breeders must be maintained and growers informed of the fact that they must secure seed from first generation crosses for planting each year and not

depend on seed selected from their own fields for maintenance of high yielding ability. The combination of pure lines, from a large number (20 or more) of ear-row tested selfed strains of corn, is now being undertaken at several experiment stations in the hope of developing highly superior new varieties which will retain their yielding ability over a number of years and not

Fig. 22.—The Original Small Plat of a Rye Importation from Russia, Planted by F. A. Spragg at the Michigan Experiment Station in 1908 from which the Rosen Rye was Selected. From this small beginning it is estimated that over one million acres of Rosen Rye are now planted annually in the northern and Corn Belt states.

be dependent for superiority on the " buoying effect " of recent hydridization.

By recombining selected pure lines, undesirable lines of heredity existent in our common corn varieties are eliminated.

In rye improvement, excellent results have been secured by careful plant selection and the proper isolation of individual plants to prevent crossing with other rye plants. By covering

the individual heads of desirable rye plants with glassine bags, self-pollinated kernels are produced and form the basis for further improvement of rye varieties. The inbred strains may be tested in short rows, kernels of each being reserved in an

Fig. 23.—Selected Plant of Detroit Dark-red Beet Planted in an Isolated Place in Order to Prevent Cross-pollination with Other Beets or with Closely Related Plants, Such as Swiss Chard and Mangels. (Michigan Exp. Sta.)

envelope, small stakes at the end of each row being marked to correspond with the numbers given envelopes holding grain from which the rows were planted. The rows giving best yields indicate the most desirable remnants, the best of

which are combined in an isolated increase plat the following year.

Marked improvement in timothy has been secured by the testing of rows of timothy planted from individual plants by clonal division (that is—by dividing roots and stolons of individual plants and transplanting in short rows). The best rows are individually isolated so that selfing is assured, and increases of the new strains obtained. The ease with which these new pure lines of timothy cross with the ever-prevalent wild and cultivated timothy plants throughout the timothy-growing regions, and the tardiness of farmers and the general market to adopt improved timothy varieties, has caused much valuable work with timothy to come to little practical value up to the present time.

In securing selfed strains of sugar beets at the Michigan Experiment Station,[1] selected mother beets are isolated at great distances, 160 rods or more, from other beets on the Experiment Station fields, and are scattered over a wide area on farms in the neighborhood. Protecting individual beets by enclosing in cages of cheese cloth is another method in use. Desirable selfed strains of field and garden beets must be carefully isolated from other beets that are allowed to produce flowers, in order to secure pure increases.

The Kitchenette squash was developed at the Minnesota Experiment Station by selfing a small early strain of Hubbard squash, reducing to a pure line, and increasing for general distribution. Similar work with cucumbers is under way at the Michigan Experiment Station.

Selecting best individuals from plants in which cross-pollination is obligatory either through self-sterility or the fact that they are dicœcious, and restricting pollination to this group of plants.—Asparagus, spinach,[2] and hemp are dicœcious, the male

[1] Office of Sugar Plant Investigations, U. S. Dept. Agr., and Michigan Experiment Station Cooperative Project.

[2] A moncœcious strain of spinach has recently been offered to the seed trade, but the type is not yet fully fixed.

plants producing pollen which is necessary in the successful fertilization of the receptive flowers of the female plants. Many strains of cabbage and beets are self-sterile.

The Washington strain of asparagus was produced by finding a male plant very resistant to asparagus rust and crossing with females showing a high resistance to this disease.

Hybridizing or cross-pollinating strains of both normally self- and cross-pollinated plants to secure desirable types which

FIG. 24.—Cross-pollination is Obligatory with Asparagus, as this Vegetable is Dioecious, the Male and Female Blossoms being Borne on Separate Plants. Selected male and female plants are planted closely together. Male plant on left, female plant at right.

may result, combining the good qualities of both the parent plants.—While occasional natural crosses occur in the field from which desirable new varieties result, modern plant breeders increase the range of possibility of securing desirable new hybrids by the artificial crossing of large numbers of plants grown under careful observation. Plants of male and female lines of parentage are carefully selected in large numbers and many combinations of lines of heritage are made.

In crossing self-pollinated plants such as wheat, oats, and barley, the common procedure is to strip alternate spikelets from the spikes or heads of selected plants before pollen is produced in the anthers, force open the glumes of remaining flowers and emasculate by removing the anthers with delicate forceps. The emasculated flowers are protected from cross-pollination by covering the spike or head with narrow bags of glassine paper securely closed and fastened with clips at the

FIG. 25.—Hybridizing or Cross-pollinating Barley Plants. Emasculated flowers fertilized artificially with pollen from selected plants are protected from cross-pollination by glassine covers. (H. M. Brown, Michigan Exp. Sta.)

base of the spike. When stigmas are ripe, anthers carrying ripe pollen are collected from flowers of plants selected for male parentage and placed in a small tin box with tight lid, for transference. The glassine bags covering the emasculated flowers (the female lines) are removed and the collected pollen quickly transferred by means of a camel's hair brush to the stigmas of the emasculated flowers. The glassine bags are immediately returned and clipped securely. The resulting kernels are, of course, hybrids of the emasculated plant (female

parent) and the plant producing the pollen used in artificial fertilization (male parent).

Corn, being open-pollinated, is hybridized to a large degree by planting alternate rows of the varieties to be crossed, plants of one variety being detasseled. Artificial hybridization of corn is more accurately controlled by covering the developing ear with a paper bag securely clipped or tied at the shank of the ear. The "tassels" (or male part of the corn flower) of a number of the strains selected for male parentage, are protected by bagging forty-eight hours before pollen is to be used.

FIG. 26.—Self-pollinating Corn. The paper bag carrying pollen from the tassel is shaken over the silks of the ear and is then placed over the ear and clipped securely at the shank to prevent cross-pollination. (Michigan Exp. Sta.)

When the pollen in the bagged tassels is ripe, and the silks of the protected ears of the detasseled plants are advanced in growth to a receptive condition, pollen is transferred to the plants selected for female parentage. A bagged tassel is cut off below the bag, shaken vigorously, and carried to the covered ear. The bag covering the protected ear on the detasseled plant is removed and the pollen-carrying bag placed over the ear. The bag covering the ear is then immediately closed and given a vigorous shaking and fastened with clip at shank. The introduced pollen strikes the silks or stigmas and fertilization is

accomplished. Placing the butt end of cut-off tassel in a small bottle partly filled with water, and attaching same with

FIG. 27.—By Field-selecting Desirable Ears from Healthy, Vigorous Plants, Improvement in Yield and in Uniformity of Type and Maturity is Secured by the Practical Seed-corn Grower. This well-known method, while much slower and less effective than the modern methods of the plant breeder, has accomplished much in the improvement of corn. (U. S. Dept. Agric.)

wire hook to the ear shank, placing covering bag over ear and tassel, is a late development in improved technique.

Examples of valuable varieties secured by hybridization

are numerous. The following are offered as typical of results secured by this method.

The Marglobe tomato is a hybrid of the Marvel and the Globe produced by Pritchard of the United States Department of Agriculture.

The Sunshine sweet corn combines the qualities of the sweet, but small, Golden Bantam with the large ear characteristic and earliness of Gill's Early Market.

Hybrids or crosses resulting from cross-fertilization, as a

FIG. 28.—Selecting Superior Seed Stock of Muskmelons. The texture, color, thickness, and quality of flesh of each melon is observed, and seed of the most desirable types reserved for increase.

rule, follow Mendel's laws of dominance, segregation, and recombination in their inheritance, and by careful selection fixed types are secured.

Selecting superior individuals of either cross- or self-pollinated plants and planting selections together for increase.—The crop-improvement methods of most farmers and seedsmen are limited to such mass selection. Examples of this method of improvement are the selection in the field of ears of corn borne on most desirable plants, the head selection in the field of cab-

bage plants for seed purposes, the plant selection of beans and peas, and the head or plant selection of wheats and oats.

Common varieties of radishes, cabbage, wheat, oats, barley, peas, beans, and many other plants are often improved by mass selection.

In case of vegetatively propagated plants, selecting tubers, root cuttings, shoots or bulbs from desirable parent plants.—The hill and tuber-unit selection of potatoes gives marked improvement in type and yield of average commercial varieties. By selecting superior plants of rhubarb for root division, much better plantings result. The strongest shoots should be taken from the best plants of artichokes for transplanting. Multiplier onion and garlic crops are improved by selecting bulbs from the best types of multiplier onions and garlic for transplanting.

Maintaining testing plats to compare new selections of promise with strains of known habits of growth and proven value.—The rod-row system, with frequent checks and several replications, is used by most plant breeders.

The trial beds of seed companies are usually large beds planted for observation, including rows of known varieties for comparison.

The systematic methods employed by the breeder of field crops are now being used by the most successful practical seed growers of garden-crop seeds.

Isolating increase fields for multiplying cross-pollinated plants.—The proper isolation of increase fields of cross-pollinated plants is of the utmost importance.

Increase fields of corn must be at least 40 rods away from other corn fields. A greater distance is desirable to prevent the occurrence of crossing.

Rye increase fields should be isolated a similar distance and all volunteer rye cut before pollination occurs.

With vegetable crops, increase fields of radishes must be at least 40 rods from other radish fields. In districts where radishes are grown for seed, volunteer radish plants cause great difficulty. Radish plants from seed disseminated from

gardens or seed fields may take their place among the common field weeds and continue as a pest for years.

Many plants not only cross within varieties but will also freely intercross with closely related members of the same family.

Beets cross freely with swiss chard and mangels, and the resultant crosses are of little value.

Cabbage, cauliflower, kale, kohlrabi and other members of the *brassicæ* family will freely intercross.

FIG. 29.—Increase Plats of Selected Strains of Open Pollinated Plants Must be Carefully Isolated. The above shows an isolated plat of Detroit Dark Red beet from seed of mother plant shown in Fig. 23.

Watermelons cross with citron; pumpkins, with summer crook-necked, bush scallop and vegetable marrow squashes. Cucumbers cross with gherkins; hence, the two must be well isolated.

Cultivated carrots cross freely with the wild carrot, and choice carrot seed cannot be grown successfully in regions where wild carrot abounds.

The parsnip, for the same reason, must be isolated from the wild parsnip.

Producing first-generation crosses of selfed strains of corn is now carried on commercially in Ohio, Iowa, Illinois, Connecticut and a few other states.

The production of first-generation crosses of tomatoes, to secure the resultant increase in vigor and productiveness, offers commercial possibilities.

FIG. 30.—View of a Typical California Seed Ranch, Showing Lettuce, Carrots, and Other Crops Growing for Seed.

When the great majority of farmers and gardeners become well informed in regard to the effectiveness of modern plant-breeding methods, and improved varieties are generally used in producing our field and garden crops, yields per acre will be increased and costs reduced, and the market quality of field crops and vegetables will be vastly improved.

CHAPTER III

THE WORK OF CROP-IMPROVEMENT ASSOCIATIONS AND COOPERATIVE SEED DISTRIBUTING AGENCIES

The use of adapted, weed-free seed of high germination from high-yielding disease-resistant varieties, by insuring greater certainty of yield and increasing the yield per unit of area and labor, lowers the cost of production, and the improved product resulting contributes to effective marketing.—D. H. Otis, Director of Agricultural Commission, American Bankers' Association.

As never before, the seed-consuming public is becoming informed in regard to the advantages to be had in planting high-quality seed of varieties of superior breeding and adaptation. The seed grower who secures the best seed stocks as the foundation for his commercial seed, and who directs the sales of his seed in areas to which it is best adapted, follows the soundest of business principles in building a continuing demand for his product as a result of satisfactory performance in the field. Superior seed stocks of practically all leading crops, both of field and garden, can be secured by the seed grower who makes the effort to obtain the best.

At the present time, the plant breeders of the United States Department of Agriculture and of the Canadian Department of Agriculture and plant breeders of practically all state and provincial experiment stations are establishing, by test, the leading varieties of field, garden, truck, and canning crops in yield and quality under varying soil and climatic conditions and are constantly bringing forth new and improved varieties of a wide range of crops which are available to any interested seed grower or seed handler. While these public sources of improved varieties have been the most prolific and effective,

there are also many field and garden-crop varieties of great merit being produced on the seed farms of seed companies and contributed here and there all over the country through the efforts of seed growers who interest themselves in plant improvement. The best seed stocks obtainable are none too good for the seed grower, who must expect to meet the keen competition of seed producers constantly striving for the betterment

FIG. 31.—Field Inspection of Seed Wheat. The Canadian Seed Growers' Association of Canada and Crop Improvement Associations of many states of the United States grow seed for certification under strict field inspection and threshed seed requirements. (Peter Stewart, Sec.-Treas., Canadian Seed Growers' Association, Ottawa, Canada.)

of their seed stocks and a public rapidly becoming more and more exacting in the demand for real seed service. Future business will be directed in increasing amounts to seed handlers who best serve the crop grower.

Crop and varietal adaptations are often of such limited range that they must be worked out for practically all localities and in many cases for particular soils. The varietal tables given on pages 417 and 423 show varietal recommendations of

field crops and garden crops for various states in the United States and provinces in Canada. They are largely the result of the plant-breeding work of experiment station and government plant breeders. Certified seed of field crops is available in quantity through crop improvement associations, and most of the varieties listed have become leading commercial varieties and are handled by seed companies serving the areas to which they are adapted.

Fig. 32.—Inspector Sampling Seed in Order to Determine Fitness for Certification. (Courtesy of Mr. Peter Stewart, Canadian Seed Growers' Association.)

Crop Improvement Associations have been of great influence in securing widespread use of superior varieties. — When a new variety is developed, and proven, by careful comparison with other varieties of known merit, to be superior, it must be brought into widespread use in order to be of great practical value. If released in small lots from the plant breeders' hands, the new variety would, in most cases, become mixed with other varieties. In spite of great merit, new varieties have small chance of achieving widespread distribution unless the seed is increased in quantity, kept pure, and sold at reasonable prices. To accomplish this purpose more efficiently, " Crop Improvement Associations," " Seed-growers' Associations," or " Experiment Associations " have been formed in practically all states

where extensive experiment station plant-breeding work is being conducted. In Canada, the Canadian Seed Growers'

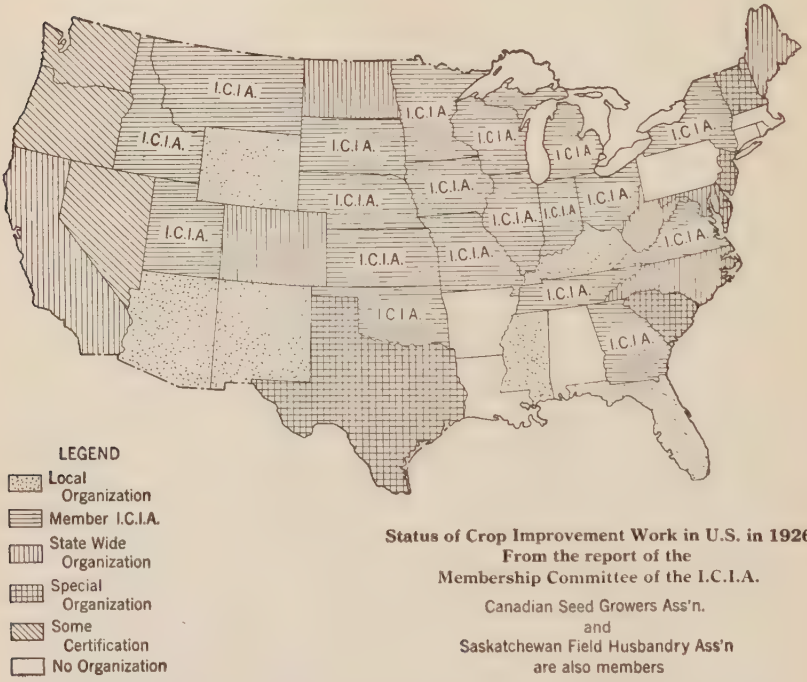

FIG. 33.—Crop Improvement Associations are Active in Nearly All States where Plant-breeding Work of Importance is Conducted by Agricultural Experiment Associations. (From annual report International Crop Improvement Assn., 1926.)

Association is represented in all agricultural provinces. Certified Seed Potato Growers' Associations in northern seed potato producing states have greatly improved the quality of seed potato stock.

These associations are made up of growers interested in

securing, developing, and selling the best of seed, and in most states and provinces many commercial seed growers and distributors are members or contract for large amounts of seed with association growers.

Most of these associations require field and after-threshing inspections, and, through their inspection service, affix seals to bags carrying seed meeting their high requirements. Such seed is known as "certified seed," since it has been inspected and certified as to variety, purity, and germination on a certain specified date, by a well-qualified inspection service.

In Canada, the inspection service is controlled by the Dominion Department of Agriculture. In the United States, the inspection service is usually developed according to plans submitted by experiment station or extension agronomists, who further render service in training and advising inspectors hired by the state association.

The crop improvement and experiment associations of the United States are of comparatively recent development, the oldest being hardly more than twenty-five years old and most of them having developed within the past ten years. The formation of the International Crop Improvement Association in 1919 gave great impetus to the formation of certified seed growers' associations and to the development and standardization of methods of producing, inspecting, and marketing certified seed.[1]

The Crop Improvement Associations of the United States confine their activities almost entirely to field-crop seeds, but here and there interest in the certification of major garden-

[1] This organization was formed as a result of a meeting called at the Minnesota Experiment Station by Prof. C. P. Bull, of state representatives interested in the improvement of farm seeds through state organizations. The states of Iowa, Nebraska, South Dakota, North Dakota, Michigan, Illinois and Wisconsin were represented. Prof. R. A. Moore of the Wisconsin Experiment Association, and J. W. Nicolson, then representing the Michigan Crop Improvement Association, were named chairman and secretary, respectively, and drew up the first constitution.

crop seed is being evidenced. With the development of plant-breeding work with garden crops, on an equally high plane as the present breeding work with field crops, the production of garden, truck and canning crop seed by crop improvement associations or similar seed-growing and certifying organizations is certain to follow. The Canadian Seed Growers' Associations have already included garden and truck crops among the crops grown for certification.

The production of certified seed potatoes by well-organized associations is a large industry in many northern potato-growing states. (Note chapter on seed-potato growing.)

THE WISCONSIN EXPERIMENT ASSOCIATION

As the pioneer state seed-and crop-improvement association, the Wisconsin Experiment Association is of particular interest. At the annual meeting of the International Crop Improvement Association held in Chicago, Dec. 1, 1926, Prof. R. A. Moore of the University of Wisconsin, secretary of the Wisconsin Experiment Association and its founder, gave the following history of this influential association:

"The Wisconsin Experiment Association was organized in 1901 and expects to hold its Silver Jubilee this year. The old grads will be back in large numbers and we are looking forward to having a most excellent time.

"In Wisconsin we have, first, the state organization. This is run independently of the sub-organizations, but in cooperation with them. Secondly, we have the county units, known as 'county pure-bred seed-grain associations' which are affiliated and known as 'orders' of the Experiment Association. Third, we have the Wisconsin Alfalfa Order, Wisconsin Hemp Order, and Wisconsin Soybean Order which are also orders of the Experiment Association. The membership in all of these organizations, which are run in cooperation with the Wisconsin Experiment Association, is approximately 5000. These people are all engaged in the work which the name of their order indicates. For instance, the members of the Hemp Order have been instrumental in putting Wisconsin on the map as a

hemp state. I think we can safely say that Wisconsin now grows and puts on the market more hemp fiber than all the other states in America combined. We are marketing through our association approximately a million dollars' worth of hemp fiber a year. The Alfalfa Order of the Experiment Association is instrumental in doing untold good for the members of this association. We have about a thousand members of this association, and much money is saved to the members of the

WISCONSIN EXPERIMENT ASSOCIATION
EXPERIMENT ASSOCIATION SEEDS.
INSPECTED IN THE FIELD AND BY SAMPLE
TO INSURE PURITY AND HIGH QUALITY

FIG. 34.—An Exhibit of the Wisconsin Experiment Association, Showing Leading Varieties of Field Crops Produced by the Plant Breeders of the Wisconsin Experiment Station and Grown by Members of the Association. (Courtesy of Mr. E. A. Holden, Asst. Secy., Wisconsin Exp. Assn.)

association through the close cooperation carried on by this organization.

"Our county pure-bred seed growers' organizations attend to work quite largely within their own county. Many of the organizations put on grain shows each year. These are usually put on before the state experiment association show is to be held. These county shows eliminate all of the poor seeds and send to the state association show only the prize winning samples for competition. This enables the state association to put on a high-grade seed show—much better than it could if it depended on having samples sent direct from the growers.

"The state association, as far as possible, cooperates with the International Grain and Hay Show and tries, as far as possible, to hold its annual show just previous to the International Grain Show so as to send its prize-winning samples to this show after having eliminated the poor samples that may have been sent in by the county shows. In this way we feel that we are able to secure a higher grade of seeds to send down to the International Show. By this hearty cooperation of

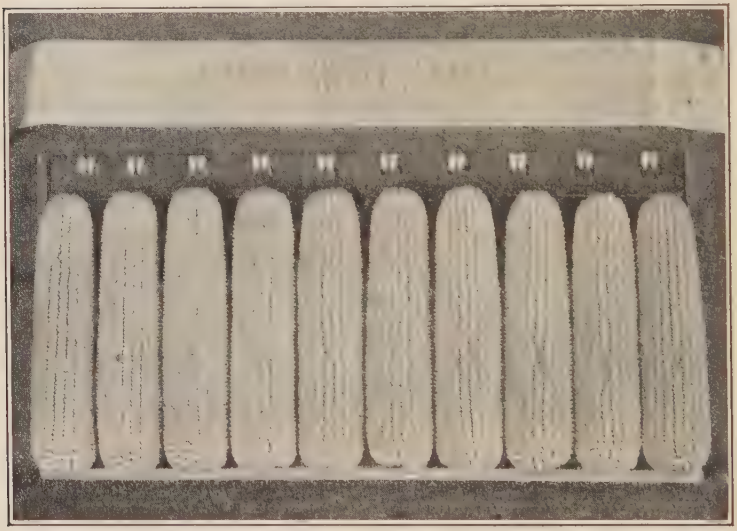

FIG. 35.—Grand Sweepstakes Sample of Corn at the Indiana State Corn Show, 1923. County and state seed shows and the International Grain and Hay show encourage seed growers in the production of highest quality seed of improved varieties, and increase the public demand for such seed. (J. Callen.)

county and special organizations which are combined with our state association, we feel we are enabled to carry on a much better and higher grade of work than it would be possible if we didn't have these cooperative bodies working with us. Through the cooperative efforts put forth by all of our cooperative bodies, the Wisconsin Experiment Association has been able to put on the market from two to three million dollars' worth of products annually.

"The Experiment Association has made two features of its work very prominent. One is the use of those seed grains that have been bred at the Station Farm and tried out under our organization in various parts of the state before being grown as seed in large quantities. The other is establishing a market for these particular kinds of pure-bred seeds and special products. I think it is safe to say that the Experiment Association has worked just as hard on the marketing of these products as it has on the development and growing of the same. One of these lines of work cannot be carried on without due emphasis being placed on the other and it is only by going hand in hand together that we have been able to bring prosperity to our large seed-grain organization."

THE MICHIGAN CROP IMPROVEMENT ASSOCIATION

This association, organized as the "Michigan Experiment Association," in 1912, and as the "Michigan Crop Improvement Association," in 1916, has stressed the field inspection of seed crops, encouraged local distribution of adapted seed of high-yielding varieties on a state-wide scale, and cooperated with the Michigan Farm Bureau Seed Department in building up a greater retail market. Several leading seed companies of the state contract for the delivery of large amounts of seed from leading growers of the association.

The use of the most effective methods of crop culture, and the encouragement of alfalfa, sweet clover, red clover, and other legumes are important projects of this organization.

Mr. H. C. Rather, extension specialist in Farm Crops of the Michigan State College and present secretary of the Michigan Crop Improvement Association, describes the present organization as follows:

"When a variety has demonstrated its merit through careful tests, it is ready for release to farmers. The Michigan Experiment Station has adopted the policy of making this release to tried individual growers in quantities sufficiently large so that the resulting crop may be handled with the usual farm equipment and, with reasonable caution, may be kept pure. In order to make the increase of such seed effective, so

that the good characters of a variety will not be lost through contamination and mixture, there is in this State an organization of farmers known as the Michigan Crop Improvement Association, which produces pure seed of the varieties developed or recommended by the Farm Crops Department of the Agricultural College, under a very rigid inspection system assuring the conformity of the seed to those standards emphasized herewith as characterizing seed of greatest merit.

"This first increase of seed, released by the Michigan State

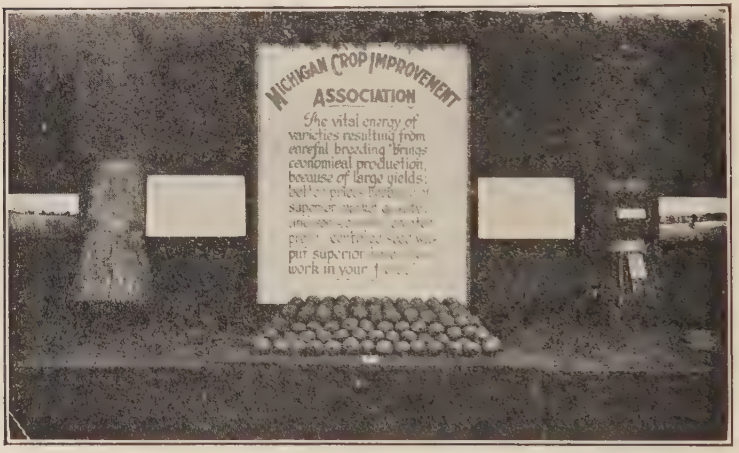

FIG. 36.—An Exhibit by the Michigan Crop Improvement Association Featuring Certified Seed of High-yielding Varieties at the Michigan State Fair, Detroit.

College for field production, is known by the Michigan Crop Improvement Association as *Elite stock seed*. It may be defined as seed of a pure line selection, or seed of exceptional merit which has demonstrated its superiority in tests conducted or approved by the Farm Crops Department of the Michigan State College. Elite stock seed may be produced by an individual grower whose work fulfills these conditions. It does not ordinarily pass through commercial channels, being used almost entirely for the purpose of introducing new varieties or improved strains in old ones.

Keeping Field Increases Pure

"The field production of seed of a variety thus introduced to agriculture is conducted by the Michigan Crop Improvement Association under a very rigid inspection system supervised by the Farm Crops Department of the State Agricultural College. The first inspection takes place in the field within three weeks of harvest. At this time inspectors have two methods of checking up on the varietal purity of the field inspection. In the

Fig. 37.—An Increase Field of Elite Seed Stock of Rosen Rye on the South Manitou Island, Michigan.

first place, only fields coming through channels of regularly inspected seed, from original Elite stock, are eligible for inspection. The history of each field inspection is recorded in the pedigree files of the Association. The inspectors' second check on purity is the character of the growing plants in the field itself. No field may pass the inspection of the Association which contains noxious weeds or mixtures not readily removable in cleaning. In order to meet these standards the growers working under this supervision rogue out all mixtures and impurities from their fields.

"The field inspection thus gives the Michigan Crop Improvement Association an opportunity to assure all of its customers that its seed is of a variety of known productivity which can

be truly labeled as to origin and varietal purity. The inspectors are paid by the association, a sufficient inspection and certification fee being charged to pay for the cost of the service.

Certifying Seeds of Merit

"The other characteristics of dependable seed are assured through a final inspection of the seed. Each grower whose field passes the first inspection submits to Association headquarters a sample of his crop just as it comes from the thresher. This uncleaned sample is given a practical cleaning over a farm-size mill with screens readily available to any seed grower. Analysis is made of the clean seed and representative samples are tested for germination. Seed which passes both the field and this final inspection becomes the *Certified seed* of the Michigan Crop Improvement Association.

Fig. 38.—Certification Tags Affixed by Responsible Agents Must Accompany State or Seed Association Certified Seed.

"The Certified seed grower labels each lot of seed he sells with Association tags which give the varietal name, purity, germination, locality where grown, and any other information of value to seed users. In addition he guarantees, to the full extent of the purchase price, that the seed which he sells will accurately conform to the analysis given on his certification tags.

"In addition, storage inspection is given in the case of corn and all registered seed and such seed is sealed by representatives of the association.

"Thus the system of the development of seed by the Agri-

cultural Experiment Station, and the production on a field scale by the Michigan Crop Improvement Association under its rigid system of inspection, points out every factor which the purchaser must consider in buying seed wisely.

Channels for Quality Seed Dissemination

"This system of crop mprovement and seed dissemination is already exerting a very potent influence on crop production in Michigan. Certified seed passes through every one of the channels through which farmers ordinarily secure seed. A large portion of it is sold directly from one farmer to another. Some growers sell their Certified seed to local dealers and elevators who remarket it to their customers. Others have standing relations with large wholesale seed houses in the State, and from these Certified seed passes through the various channels leading to the ultimate user.

"The Seed Department of the Michigan State Farm Bureau, a cooperative organization for seed dissemination, has been by far the largest individual handler of Michigan Certified seeds. It conducts cooperative marketing pools of the various varieties certified, and many of the growers find it profitable and desirable to consign their seed for sale to this organization. Relations have been established between the Farm Bureau Seed Department and cooperative elevators throughout the State, and also similar organizations in several other states which find Michigan seeds desirable. The market for the Michigan grower of Certified seed is thus greatly widened.

The Rapid Spread of a New Variety

"The efficiency of seed dissemination work in Michigan has been greatly increased by this mobilization of the various forces interested. For example, in the space of but eight years' time Robust beans have been increased from their initial release by the Michigan Experiment Station to a point where they to-day seed from 12 to 15 per cent of Michigan's great bean acreage. In addition, the variety plays an important part in the bean culture of states like New York, Minnesota, and California. This quick increase of pure seed, together with the known productive merit of varieties thus handled, exerts an influence on crop production in the State which annually adds wealth running in the millions.

Starting Out New Certified Seed Growers

Fig. 39.—Inspector Sealing Bags and Affixing Certification Tags. Sealing by a responsible association working in cooperation with state extension department or state agricultural commissioners insures protection to the reputation of the seed-grower and to the crop of the seed-user. (Courtesy of Montana Seed Growers' Association.)

"With the ever-increasing demand for Certified seed, there has been need for an increasing number of good seed producers. More new growers are required each year than can be started with seed from Experiment Station increase fields. The choicest lots of regularly inspected seed are therefore set aside in a special grade of merit known as *Registered seed.* The Registered seed consists of a limited amount of the most desirable lots for seed increase. New growers who desire to produce seed under the inspection and certification of the Michigan Crop Improvement Association must make their start with seed coming directly from the Experiment Station or with seed of this Registered grade. Their fields are then eligible for inspection, as long as they meet the standards laid down by the Michigan Crop Improvement Association."

SPECIAL SEED-GROWING AND CERTIFYING ASSOCIATIONS

In addition to the statewide crop improvement associations, organizations of growers of special crops have been formed in many states and

localities. Certified seed potato growers' associations have been developed in Maine, New York, Michigan (affiliated with Crop Improvement Association), Wisconsin, Minnesota, North and South Dakota, Idaho, Ohio, Pennsylvania, Maryland, Indiana, and a few other states. The inspection and certification methods of these organizations are treated in Chapter XII on Seed Potato Production.

Grimm alfalfa seed growers' associations have been developed in Idaho, South Dakota, North Dakota, Montana, and Utah. Cotton-seed growers' associations have developed locally in several southern cotton-growing states. (See Chapter XI on Cotton-Seed Production.) In Idaho an association of Ladino seed growers has been developed.

The soybean seed growers have formed many state associations and a national soybean association which meets annually.

COOPERATIVE SEED DISTRIBUTION BY FARM BUREAU SEED SERVICES AND OTHER COOPERATIVE AGENCIES

With the formation of the American Farm Bureau, the cooperative handling of seed was given a great impetus. In 1920, the Michigan Farm Bureau Seed Department was formed for the purpose of securing adapted domestic clover and alfalfa seed either direct from growers or from dependable dealers, and also for the handling of certified seed produced by the Michigan Crop Improvement Association.

The Farm Bureau Seed Department developed rapidly and proved to be a major factor in the rapid increase of alfalfa in Michigan. For several years the Michigan Farm Bureau was called upon to render service in Indiana, Ohio, New York, Pennsylvania, and other states where Farm Bureau service was active. In 1921 the Grange League Federation of New York established a separate seed department which, in a few years, developed a tremendous business in New York and neighboring states. The Ohio Farm Bureau has distributed seed of known origin and high quality since 1920, and in 1925

the Indiana Farm Bureau established a separate seed-handling service.

In 1925, the Federated Seed Service was incorporated with headquarters in the American Farm Bureau offices at Chicago. This organization was formed by the Michigan Farm Bureau Seed Department, the Ohio Farm Bureau Seed Service, the

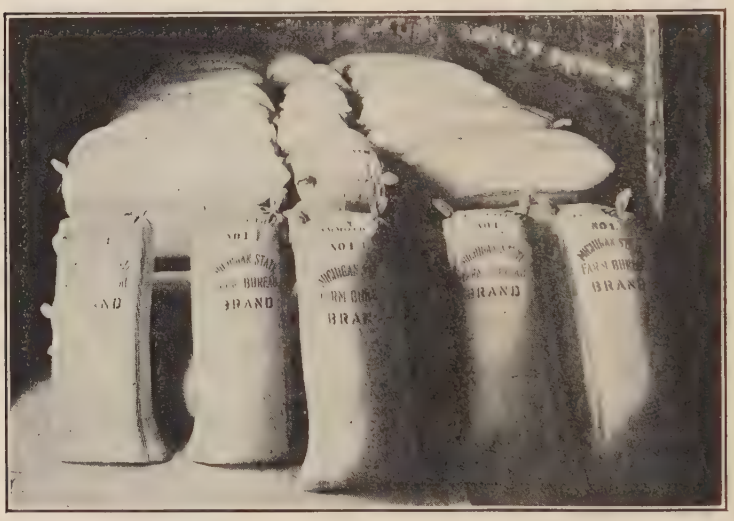

FIG. 40.—A Car-load Consignment of Alfalfa Seed Leaving the Michigan State Farm Bureau Seed Department for One of the One Hundred and Eighty Cooperative Elevators Handling Farm Bureau Seed in Michigan. (Courtesy of Carl F. Barnum.)

Grange League Federation Seed Department of New York, the Pennsylvania Seed Service, Maryland Agricultural Corporation, Virginia Seed Service, Indiana Farm Bureau, and the Wisconsin Farm Bureau. For a period of four months during the winter and spring of 1925 and 1926, an executive secretary was maintained for the purpose of aiding in organization and inspecting seed purchased for members, chiefly to verify the source of alfalfa and clover seed as to domestic origin.

FIG. 41.—Seed Storage and Shipping Room of the Cooperative G. L. F. Seed Department, New York.

FIG. 42.—The Cooperative Grange League Federation has Built Up an Enormous Business in New York State and Adjacent Territories in Known Origin Alfalfa and Clover Seed and in Adapted Varieties of Other Crops, Particularly the High-yielding Wheat, Oats, and Barley Varieties Developed by Cornell University. The above shows an assortment of packages of various sizes ready for loading a car on the car-door distribution plan. (Courtesy of A. L. Bibbins, Mgr., G. L. F. Seed Dept.)

In July and August of 1925, representatives of the various seed departments of the Federated Seed Service, and President O. E. Bradfute and other officers of the American Farm Bureau, accompanied by agronomists of various interested states, and H. L. Westover and G. C. Edler of the United States Department of Agriculture made a tour of the alfalfa seed-producing states of the West and Northwest, inspecting the alfalfa experiments of the Kansas Agricultural College enroute. The effect of this tour was to increase the flow of adapted alfalfa seed from

Fig. 43.—Members of Federated Seed Service, Representing Cooperative Seed-distributing Agencies of Corn Belt and Northern States Inspecting a High Altitude, Utah, Alfalfa Seed Field in Early August, 1925. This tour added impetus to the movement of adapted northwestern seed and Utah seed into the Corn Belt and northern States.

Utah, Idaho, South Dakota and Montana producing areas to the Corn Belt and northern states. Great interest was directed toward the need of a national law (since passed) to give relief from the damage being done by large importations of undesirable clover and alfalfa seed.

The Federated Seed Service continues in operation, but with the Gooding-Ketcham bill in effect and sound connections formed in the proper domestic alfalfa and clover-seed producing areas, the inspection and verification service is left entirely to individual managers.

It is very likely that a system of verification of source of seed, based on a study of the seed and an inspection of lot records, may be undertaken by the Bureau of Economics of the United States Department of Agriculture. This service, when established, will be available to the general trade as well as to the cooperatives.

Meetings of seedsmen and agronomists were held in June and in December, 1926, in Chicago, on the call of Mr. W. A. Wheeler of the Bureau of Economics, United States Department of Agriculture. Sentiment at these meetings was strongly in favor of the establishment of a system of verification of seeds as to source by the United States Department of Agriculture.

At the meeting of the Wholesale Grass Seed Dealers' Association in Detroit, June 28, 1927, arrangements were made by eight leading seed companies to give the seed verification service of the United States Department of Agriculture a trial during the following year. The name of the association was changed to the Farm Seed Association of North America. At this meeting also, representatives of the Seed Trade, International Crop Improvement Association, American Society of Agronomy, the United States Department of Agriculture and Seed Analysts of America, met to form the North American Seed Committee.

The purpose of this advisory committee is to secure close cooperation between those engaged in producing and handling seed and those interested chiefly in its producing value on the farm.

CHAPTER IV

SPECIAL CULTURAL PRACTICES AND EQUIPMENT NECESSARY IN GROWING GOOD SEED

At no time in the history of the crop can greater results be secured at less labor and expense than with the seed.—NORTON and LEATHERS, U. S. Dept. Agr. Bul. No. 7.

The seed grower must first of all be a good farmer. It is necessary that he know effective methods of plowing and fitting land, maintenance of soil fertility, fertilization of special crops, seed cleaning, testing, and seed treatment, effective methods of cultivating, harvesting, curing, and storing his crops. He must have thorough knowledge of crop-disease and insect control. His cropping system should follow a carefully planned scheme of rotation in order to maintain fertility and control crop pests. He should have a knowledge of effective methods of farm management to enable him to handle labor efficiently, and he may often find it advisable to combine other phases of farming with seed growing to utilize roughage and by-products, such, for instance, as feeding cattle, hogs, sheep, and poultry, or maintaining dairy cows.

The seed grower must have special knowledge of varieties and methods of varietal improvement and of the particular methods applicable to the seed crops which he produces in securing high yields of seed of high quality and in preparing seed for market.

He must be a good salesman of his product and keep thoroughly informed on market demands and conditions.

The seed grower's equipment usually includes the best of general farm equipment, such as the most efficient type of

plows, harrows, cultipackers, drills, cultivators, and harvesting machinery, and, in addition, special equipment for threshing and seed separation and for the curing, cleaning, and storing of seed.

The good seed grower belongs to a highly intelligent group of farmers engaged in the production of a high-quality product for a special market. The field offers opportunity for applica-

FIG. 44.—Seed Production Cannot be Successfully Carried on in Neighborhoods where Weeds are Allowed to Run Riot. (Photo by J. C. Allen.)

tion of the best of business brains and intelligence and the most highly developed skill, with assurance of recompense, both financially and in the satisfaction of rendering service to civilization.

Secure the best obtainable stock seed of varieties adapted to local conditions and in demand on the market.—In the production of seed of field, garden, truck and canning crops, it is of basic importance that the best obtainable seed stock of

most valuable adapted varieties be obtained, not only because higher yields of seed are thus secured but because such varieties are in greatest demand by the ultimate consumer.

New and improved varieties are constantly being developed and constant effort should be made to secure seed for testing and increase when found to be superior under local conditions. There are many very inferior stocks in common use, and great loss of time and money results to the grower who continues to produce such varieties for seed, as compared with results to be secured from superior strains.

In securing original seed stock, great help can be obtained from state experiment stations and the United States Department of Agriculture in getting information as to best varieties and dependable sources of seed. The matter of securing seed of best varieties is given first importance in dealing with effective seed production of all crops discussed in subsequent chapters.

Proper isolation of cross-pollinated or open-fertile plants is frequently one of the major problems of the seed grower. In growing seed of varieties of corn, radishes, cucumbers, melons, beets, cabbage, and many other plants, it is necessary to isolate the field at distances of 40 rods or more from other varieties with which they may cross. Neighbors must frequently be induced to grow the same variety in adjoining fields as is being produced for seed by the seed grower. Volunteer plants must be destroyed. Volunteer corn plants must be cut or detasseled before pollen is distributed. Radishes tend to become common weeds in radish-growing regions and are controlled with great difficulty. Wild plants of closely related species, particularly wild carrot and parsnip, may render seed growing of these crops a difficult matter in some locations. Not only must there be isolation of varieties but often of members of the same family, as cabbage and cauliflower and other related species of the *brassicæ*. The matter of proper isolation is also dealt with in treating seed production of individual crops in this book.

Plant on clean soil best suited to the need of the crop.—In general, well-drained soils well supplied with the mineral elements of fertility and with organic matter are best for seed production. Individual crops, however, have particular adaptations which must be dealt with separately. For instance, beet seed develops best on a silt or clay loam; corn on a loam or silt loam; potatoes on sandy loam; alfalfa, clover, and

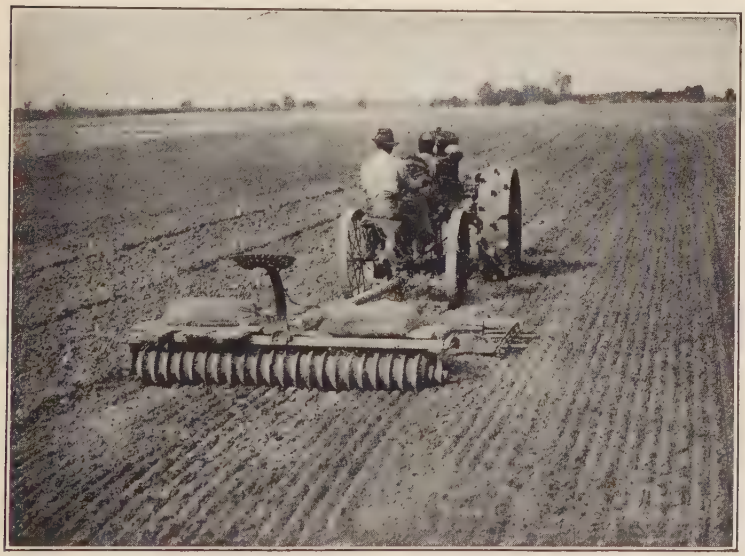

FIG. 45.—The Cultipacker is an Essential Implement for Use in Final Fitting of Seed Beds. (J. C. Allen, Indiana.)

Kentucky Bluegrass on soils well supplied with minerals, particularly lime; radishes on sandy loam; melons on light sandy loam. Heavy crops of tomatoes and cucumbers for seed are preferably grown on a silt or clay loam.

New lands offer great advantage in being comparatively free of soil carrying plant diseases, and of weed seeds and many insect pests. Potatoes from newly cleared lands are generally unusually free of common potato diseases. Peas are often

grown for seed on new land to control root rot, watermelons to control fusarium, beans to check anthracnose damage, and beets to control rhizoctonia.

Wild buckwheat often becomes a common weed of long-cultivated land, hence the growing of radishes for seed on newly cleared land is a common practice, since the wild buckwheat seed is very similar in size and is separated from radish seed with difficulty.

Red clover is being planted in new areas for seed production, because of the widespread distribution of buckhorn and other weed seeds in the older clover-growing districts.

Prepare land thoroughly, using best types of labor-saving equipment.—Thorough fitting of the soil is of primary importance in the production of seed crops since a vigorous and uniform growth is necessary and freedom from noxious weeds and insect injury is imperative. For nearly all seed crops, a well-settled, finely surfaced seed bed is necessary. Fall plowing is frequently advantageous in destroying cut worms, wire worms, white grubs and other insects and in allowing opportunity for the throrough settling of the seed bed and early fitting in the spring.

Spring and fall plowing should be followed by the use of proper harrows and the cultipacker and smoothing harrow in fitting a good seed bed. Weeds are most economically and effectively controlled at the time of fitting the seed bed for cultivated crops, and a good job of seed-bed fitting will greatly reduce the labor and expense necessary in controlling weeds after the crop is planted.

Fertilize with a high-grade commercial fertilizer, or acid phosphate on land well supplied with organic matter.—The fertilizer requirements of soils are extremely variable, but in general, it may be stated that seed crops require readily available plant nutrients. Owing to the fact that most soils are deficient in phosphorus and that this element is largely used in seed formation, applications of phosphate-carrying fertilizers are usually advisable to all but the most fertile soils.

To get best results in seed production, ample applications of a high-grade complete fertilizer, high in phosphorus and carrying needed amounts of nitrogen and potash, are usually required. From 300 to 1000 pounds of 4–8–6 or a 4–12–6 is adapted to average used soils in older farming sections of the Northern, Corn Belt and Eastern regions. An ample supply of phosphorus hastens maturity. On soils well supplied with

Fig. 46.—Community Treatment of Seed Potatoes with Corrosive Sublimate at a Wisconsin Cooperative Creamery Plant. (Courtesy of C. A. Brigham, U. S. Dept. Agric.)

organic matter by application of manure or by turning under legumes, 300 pounds or more of 16 per cent acid phosphate or 125 to 200 pounds of superphosphate may be sufficient. The proper use of a phosphorus-carrying fertilizer is of utmost importance in older agricultural areas in growing plump, properly matured seed crops.

On the suprisingly fertile soils of western irrigated regions, mineral fertilizers are not in common use at present. Some of these soils, as in the Rockyford district in Colorado, have an

excess of nitrates which promotes vegetative growth and inhibits seed development.

It is important that sufficient organic matter be present in soils used for seed production, to maintain soil condition and moisture-holding capacity. The proper fertilization of seed

FIG. 47.—Homemade Outfit for Copper Carbonate Treating of Wheat for Stinking Smut. Two bushels of wheat are put into the barrel to which is added four ounces of copper carbonate, and the barrel is then whirled for two minutes, after which it is opened up and the wheat dumped into the hopper beneath, where it is shoveled into the sacks while the next treatment is going on. Approximately fifty bushels per hour can be treated for stinking smut with this outfit. (J. C. Allen, Indiana.)

crops must be worked out by test and experience on each particular soil.

Large amounts of fertilizer or lime should be applied broadcast with a fertilizer distributor when fitting the seed bed. In applying fertilizers at planting time, through fertilizer attachments to drills, not more than 50 to 100 pounds should

be applied per acre. Muskmelons are especially susceptible to injury resulting from fertilizer application made with seed and fertilizer should be applied broadcast before planting seed of muskmelons or applied as a top dressing when plants are well established.

Treat seed to control plant diseases and insects.—Crop injury due to plant diseases and insects, largely carried by the seed planted, causes a tremendous annual loss.

In recent years, effective methods of seed treatment have been developed, and their use may be considered essential in the production of seed and market crops.

It is of particular importance that the seed grower control plant diseases, not only to prevent direct loss in his fields but to prevent the tremendous loss which results to general crop and garden growers who may buy and plant diseased seed. Whether or not disease-free strains are planted, seed treatments are advisable and are safe insurance.[1]

Plant at proper time, rate, and depth.—In growing most annual seed crops, it is of the utmost importance that the crop be planted at the proper time to insure a good start and utilize the full available season for maturity.

In general, the seed crop should be planted early in the season for the particular crop.

Cool-season crops, such as peas and beets, can be planted early in the spring.

Corn, beans, melons, and cucumbers can be planted when the ground is well warmed up. Transplanted crops, in general, should be set out when ground is thoroughly warmed and danger of frost is past.

[1] See Appendix, pages 424–432, for: (1) The formaldehyde and copper carbonate treatment used in controlling the bunt or stinking smut of wheat, and the formaldehyde treatment for the stripe and covered smut of barley, and the loose smut of oats. (2) The hot-water treatment for controlling the loose smut of wheat. (3) Fumigation of seed with carbon disulphide. (4) Corrosive sublimate treatment for scab and black scurf (rhyzoctonia) of potatoes.

Seed crops are usually planted at rates of planting less than for general crop production and transplanted crops are set at distances which provide ample soil area for full development of seed.

Potatoes, on the other hand, are generally spaced close in the row where whole tubers of right size are produced for seed.

FIG. 48.—An Indiana County Agent Testing the Germination of Seed Corn for Farmers of His County with the Improved Rag Doll Seed Corn Tester. (Photo by J. C. Allen, Purdue University.)

Proper depth of planting is of great importance but varies with seed, soil, and moisture conditions. Peas are usually planted at a depth of 3 inches, beans at $\frac{1}{2}$ to 2 inches, according to moisture in the soil. On a well-prepared seed bed, shallow planting for most seeds is recommended.

Use best-adapted drills and planters and keep drills clean.—In order to secure an even and accurate distribution of seed, the best types of modern makes of seed drills and other planting

machinery should be employed. Grain drills and grass seed, clover, and alfalfa-seed drills reduce the amount of seed needed per acre, and plant evenly and at proper depth.

Corn, bean, pea, and beet drills plant seed in rows at proper distances, marking at the same time. If large areas are to be planted, 4-row drills plant more economically than 2-row drills.

Potato-planting machines, of a type permitting inspection

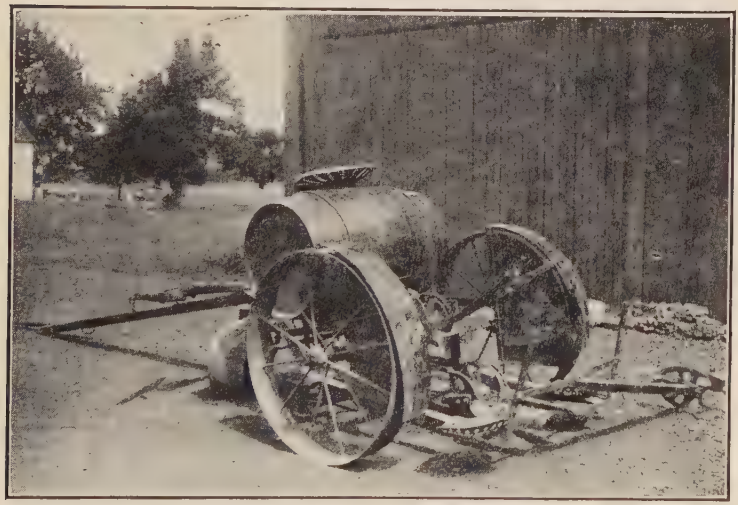

FIG. 49.—The Transplanting Machine Greatly Lessens the Labor and Expense of Setting Out Small Plants.

of seed as it is dropped, save much labor in planting and drop seed uniformly.

Transplanting machines of 2-man type, with watering attachment, not only greatly reduce the expense and labor of transplanting but also make it unnecessary to plant when soil is wet. These machines are used in planting cabbage, tomatoes, tobacco, sweet potatoes and other plants, and may often be profitably employed in transplanting certain root crops such as beets and radish plants.

For small areas and for certain small garden seeds, garden drills are employed. For large areas, they are often hooked up in gangs and pulled by a small tractor. Radish seed and seed of onions, beets, lettuce, carrots, etc., are planted with garden drills.

Hand planters of the "jabber" type are employed in planting melons, cucumbers, squash, pumpkins and seed corn when planted in hills. When used for planting vine seeds, it is customary to bolt a block of wood at the proper distance from the bottom to insure planting at right depth ($\frac{1}{2}$ to 1 inch).

Particular care should be taken, before planting seed crop, to clean seed drills and planting machinery thoroughly of all seed which may be retained from previous use, so as to prevent mixing.

It is a good practice to wash drills and seed tubes with formaldehyde solution (1 pint to 30 gallons) to kill spores of plant diseases which may be carried over from plantings of diseased seed previously made.

Time spent in calibrating, adjusting, and repairing drills will pay a big return. Drills may be tested by driving on a hard road and noting drop, or by jacking up the frame so as to lift wheels several inches, revolving wheels, and noting accuracy of drop.

Drills that tend to crush seed should be avoided, and great care taken in choosing plates of proper size for seed and drop required.

Fertilizer attachments are made for grain and grass-seed drills and corn, bean, and beet drills and various planters. It is not advisable to apply more than 50 to 75 pounds per acre of fertilizer in the row when planting intertilled crops. Three hundred or more pounds per acre can be safely drilled with grain or grass-seed drills.

Where onion smut is a serious disease, use drills equipped with a device which permits of sprinkling a solution of formaldehyde (1 pint to 16 gallons) in the row with the seed, using about 200 gallons per acre.

In using drills, great care should be taken not to plant seed too deep. The use of the cultipacker or roller after drilling firms the soil around the seed and is beneficial to practically all seed in insuring a more rapid and more even germination, and with small tender intertilled crops, cultivation may start more quickly.

Give frequent and thorough cultivation to intertilled crops, using most effective type of cultivator attachment.—Make early cultivation to good depth and later cultivations shallow.

FIG. 50.—Mowing Sweet Clover and Weeds on Irrigation Banks in Utah to Prevent Seed from Developing and Mixing with Adjoining Field of Alfalfa Grown for Seed.

Cultivation made at the right time and with the right implements greatly reduces the cost of weed control—the chief object of cultivation. Before the crop appears above ground, the spike-tooth harrow, with teeth slanting slightly backward so as not to disturb seed, may be used to great advantage on all but the shallowest-planted crops.

Weeders, or slender-toothed harrows, are even better for early cultivation before plants are up.

As soon as plants appear in the row so that rows may be

followed, the first cultivation with the cultivator may be given. This cultivation should be fairly deep (3 or 4 inches) using the tongue or shovel types of attachment, and cultivating close to the plants on the row. The root growth is but slightly developed at this time and does not spread far from the plants into the rows. Fenders are necessary when plants are small, to prevent covering. Later cultivations should be made to comparatively little depth (approximately 2 inches or less) and should not come so close to the plants in the row. The blade, duckfoot, half-sweet type of attachments slip just beneath the surface of the soil, effectively killing weeds and leaving a loose mulch without pruning feeding roots.

In the case of corn, beets, beans, and practically all intertilled crops, the root growth interlaces between the rows, coming close to the surface after thirty or forty days' growth. Hence, cultivation should not be made at a depth which prunes the important feeding roots. If the ground has been well fitted, from three to six cultivations are sufficient. In general, it is necessary to cultivate every week or ten days during the early period and active period of growth, ceasing cultivation when plants fill the rows and injury may result.

In growing intertilled seed crops, frequent hoeings with well-shaped shallow-bladed hoes are advisable. After plants are too large in row for convenient hoeing, weeds should be pulled by hand, if not controlled by previous hoeing and cultivating.

Rogue fields to remove weeds, off-type plants, diseased plants, and crop mixtures.—As the seed crop approaches maturity, it should be carefully rogued. The field is thoroughly inspected, and all weeds, diseased plants, off-type plants, or crop mixtures are pulled or cut out with the hoe. In case the crop is near maturity, these rogued plants should be removed from the field and burned.

Potato fields are usually rogued three or more times and diseased and off-type plants removed and burned.

In the case of peas and beans, rogueing at early stages of

growth is often necessary. The rabbit-ear type of rogue in garden peas shows when the peas are 4 to 6 inches high; the stipules, instead of being circular, are narrow and pointed in this off-type and grow up like rabbits' ears.

If allowed to go until pods are formed, vines are badly interlaced and many plants of this inferior type will be missed and crop damage result through tramping.

FIG. 51.—Rogueing Off-type and Diseased Plants from a Seed Field of Garden Beans.

The Alaska pea, the most important canning variety, often contains a rogue which has a dark-colored seed, remaining dark in the can. This rogue is easily removed by pulling at blossom time, since its blossom is purple, while the Alaska bloom is white.

At blooming time, varietal mixtures may be noted through difference in color of blossom.

Red kidney beans are lessened in value through the presence of a red-bean mixture which loses its color or bleaches when

soaked before canning or cooking. This undesirable bean is more viny and upright in its character of growth and may be effectively rogued from blossoming stage to maturity.

The matter of effective rogueing is of necessity taken up in dealing with each crop discussed in subsequent chapters.

Harvest when properly mature, using most effective harvesting machinery.—In the handling of practically all seed

FIG. 52.—Stacking Small Grains in Well-made Stacks or under Roof until Threshing Time Insures Seed of Better Color and Germination.

crops it is important that the crop be harvested as soon as it is properly mature and weather conditions permit. Risks of weather damage, resulting in discoloration or freezing, both of which injure appearance, keeping qualities, and germination, increase with every day the crop stands in the field, as does also the likelihood of loss through shattering and other causes, such as insects, disease, animal and bird depredations. Seed harvested before maturity is likely to be poorly filled and of poor

appearance, and while germination may be satisfactory, resulting growth may be weakened. In the case of soft pulpy fruits such as melons, tomatoes, and pumpkins, over maturity may cause decay which will be likely to reduce germination and greatly injure the appearance of the seed. Good seed should be bright in color and plump in appearance and can only be produced by harvesting at the right time and protecting the seed from rain and frost damage.

Efficient binders for small grains and mowers with binder attachment and vine lifters for alfalfa, peas, vetch, and other viny plants should be used.

Many garden seeds, such as beets, radishes, cabbage, and lettuce, must of necessity be harvested by hand, using hand clippers or reaping hooks and curing under proper conditions.

Onion seed is cured under cover in humid areas; lettuce seed is handled and cured on canvas sheets to prevent the loss of shattered seed; beets are usually tied up in bundles and shocked after cutting by hand.

Field and garden crops are usually cured for a period of several days to a week in the field.

Small grains, beans, alfalfa, and clover for seed, after sufficient field curing, are generally stored in well-made stacks or under a roof until threshing time, thereby insuring a better color of seed and lessening risk of weather damage. Only in irrigated regions, or under very favorable weather conditions, should threshing be done from the field.

Field corn and sweet corn should be husked early and dried thoroughly under well-ventilated conditions. If left in the husk on the stalk, serious injury from molds and frost damage usually results.

Thresh or separate seed with efficient machinery and keep separators clean.—The standard modern grain separator is equipped with screens which may be utilized in threshing a large number of field and garden crops having seed of various sizes. The common grain separator used in threshing wheat, rye, oats, and barley can also be used to thresh alfalfa and clover

seed, beans, peas, radishes, with proper adjustment of concaves and screens. Beans and peas are handled to much greater advantage by using a "beaner," a special thresher equipped with two sets of cylinders, one running slowly to remove overripe beans or peas without splitting, and the second running

FIG. 53.—The Seed Grower Should Own All Necessary Seed Threshing or Separating Machinery. The use of itinerant threshers often causes mixing of seed with other varieties. Canvas tarpaulins spread under and around the separator prevent the loss of much seed, an important item in the case of small seeds of high value.

at high speed to remove tight-podded seed. Clover and alfalfa are most effectively threshed in a special clover huller.

Seed of melons, cucumbers, and tomatoes is separated by the use of a specially constructed thresher. In this machine the fruit passes through a set of corrugated rolls so adjusted as to crush the fleshy fruit, releasing the seed. This pulpy mass carrying the seed now passes into a slowly revolving cylinder made

of screen wire of proper mesh and set at a slight angle. The seed and juice fall into a receptacle below, and the coarse pulp passes on to the end of the revolving cylinder.

Many seeds must be threshed by hand with flails or small hand separators. Carrot seed, if threshed through the separator, will contain many fine sticks difficult to remove in the

FIG. 54.—Cucumbers Grown for Seed in Jackson County, Michigan. This machine breaks the rinds of the ripe cucumbers and deposits the pulp and seeds in the pit shown beneath it. After fermentation the seeds are washed free of pulp and taken to the company's warehouse to be dried by special air driers. Washing takes place in especially built washer as illustrated. (Courtesy of S. M. Isbell Co.)

cleaning process, hence it is necessary to thresh the heads lightly with the flail in order to avoid breakage of stems. Lettuce seed and onion seed are usually flailed.

Hand separators are sometimes used in threshing beets, fiber flax, and broom corn.

The seed of the larger pumpkins and squashes must be removed by hand. It is the usual practice to cut the fruits

open with a dull knife or cleaver, scooping out the seed with large iron spoons.

The seed of certain of the pulpy fruits is incased in a pulpy sack which is difficult to remove by ordinary washing. Cucumber, muskmelon, watermelon, and tomato seed are, as a usual practice, fermented after screening for several days, and are then washed and cleaned. Squash seed must not, however, be fermented, because the seed coat is corky and easily dissolved.

It is customary to separate squash seed from its pulpy attachments by churning with a rake or potato hook.

Special operations in threshing are described in dealing with each crop in subsequent chapters.

The seed grower should own all necessary seed-threshing, or separating machinery and keep it at the farm. If an itinerant thresher is used, the ledges, corners and screens should be carefully cleaned of all seed before the seed crop is threshed. This necessitates taking the machine apart and cleaning with whisk-broom and blower in order to prevent mixing of stock seed.

Dry seed thoroughly.—If seed of most crops, other than pulpy-fruited plants, has been properly matured and cured in the field under favorable weather conditions, it should be sufficiently dry for storage after threshing.

Sweet corn, however, and field corn in Northern States, should be dried on the ear in a well-ventilated crib or seed house. The ears should be hung on wire hangers, or placed in wire-mesh bottomed trays, or narrow cribs, and artificial heat used to insure drying. Some of the extremely early varieties of sweet corn, maturing in late summer or early fall, may be cured in narrow cribs not to exceed 2 feet in width, which may be made of close-meshed fence wire.

Seed of pulp fruits should be dried on cloth-covered racks in the sun, or dried under cover with steam dryers. It is sometimes found advisable, immediately after washing, to remove the loose water through the use of a centrifugal machine

similar to that used in laundries for drying clothes. Tomatoes are usually handled in this way.

The seed of beets, lettuce, and cabbage, and other garden seeds that have a tendency to dry slowly are usually dried in the sun in the West or on the barn floor under humid conditions, being spread out thinly on canvas sheets and stirred frequently until dry.

Small grains, corn and beans in a moist condition may be

FIG. 55.—Drying Racks Made of Cloth Stretched on Frames are Used in Drying Seed from Fleshy Fruits or in Drying Wet Seed of Any Kind.

dried by use of artificial dryers to reduce moisture to 15 per cent or less for safe storage.

Dryness is essential in maintaining the vitality and appearance of stored seed. In seed stored under damp conditions molds develop readily. Seed quality depreciates and vitality is seriously impaired. The germination of seed carrying excessive moisture (15 per cent or more) is seriously damaged by freezing. Dry seed, on the other hand, will withstand freezing with little impairment of vitality.

Seed not properly dried, if left in bins or in sacks, will heat, and its vitality will be greatly reduced.

Clean seed for storage or marketing with a good fanning mill, and deliver at once, or store.—A good type of fanning mill with proper assortment of screens is part of the necessary equipment of the seed grower. Not only does he need the fanning mill to clean his own seed but he must use it in cleaning seed for sale. An efficient fanning mill removes many weed seeds, dirt, light seeds, cracked seeds, and chaff. The weight

Fig. 56.—The Fanning Mill is Effective in Removing Many Weed Seeds, Dirt, and Light Seeds from Small Grains.

per bushel, purity, and appearance are improved by the fanning mill.

Grain as it comes from the thresher is seldom in condition for planting.

In the case of seed of cucumbers, melons, tomatoes, etc., light seed of weak vitality, bits of pulp rind, and dirt are removed by running the seed through the fanning mill. Beet

and carrot seeds carry broken stems which may be partially removed by use of the fanning mill. Weed seeds, sticks, stones, and pieces of pods are removed from radish seed. The mill is also used in grading radish seed.

The fanning mill equipped with seed-corn screens is often used in grading or cleaning shelled seed corn.

Seed beans and peas are often cleaned with a fanning mill and then hand-picked with a special hand-picking machine.

Much of the weed-seed content and dirt may be removed from clover, alfalfa, and sweet-clover seed by use of the fanning mill, but not enough to put the ordinary farm seed of clover and alfalfa in condition for planting. Special machinery not found on the average seed farm is necessary to remove buckhorn, catchfly, Canada thistles and many other troublesome weeds from clover seed.

The contracts of many seed companies require cleaning with fanning mill on the farm before seed is received.

The thorough cleaning of seed results in a better market price and greater satisfaction to purchasers. It is of the utmost importance that the seed grower clean thoroughly the seed to be planted on his own farm. The great majority of our noxious weeds have been introduced in seed.

The fanning mill of the type used on the farm will not, however, remove weed seeds of the same size and weight as the seed being cleaned. Such weed seeds can only be removed by the special machinery of the large seed house.

Store under dry, well-ventilated conditions.—After thorough curing, seed should be stored in bins or bags in a dry, well-ventilated house, or rodent- and sparrow-proof room or seed house. Seed that is properly dried and left in a dry condition is not easily injured by temperature changes, unless extreme.

Many seeds, such as corn, beets, and beans, have a tendency to absorb moisture and deteriorate in vitality and quality if stored under moist conditions.

Dryness is essential. Molds develop under moist conditions, and freezing greatly damages moist seed. Heating in

FIG. 57.—The Curing of Seed of Corn, Sweet Corn, Onions, Beets, and Many Other Crops Must be Done in Thoroughly Ventilated, Well-constructed Curing and Storing Houses.

FIG. 58.—Interior View, Showing Onion Seed Curing on Shelves of Wire Poultry Netting.

warm weather may also cause great damage to seed which has absorbed moisture, or which has been improperly cured.

The floors and sides of bins should be of strong, tight construction, and should be made mouse- and rat-proof by using metal or screen wire for corners. The roof must be closed at the eaves and the windows screened to prevent sparrows from causing damage.

Bins should be made so that they may be tightly closed for carbon disulphide treatment, if the treatment is needed to control storage insects. The seed grower will often find it advantageous to build a specially constructed seed house, connecting fanning mill with bins by chutes so that bins may be filled as seed is cleaned, and also constructing bins in such a way that seed may be carried by gravity through discharge chutes into bags or wagon bed. Chutes should be so built that they can be opened and cleaned or constructed of sheet metal with smooth inside surface and no sharp elbows or corners.

The saving of labor in a well-arranged seed house may soon pay for cost of construction.

The grower of seed corn will find a special drying and storage house an essential part of his equipment.

Use clean strong sacks for seed, tagged inside and out.—In shipping to customers or to seed warehouse, seed should be put in clean, strong bags with shippers tags both inside the bag and strongly attached outside, since outside tags are sometimes pulled off and seed may be lost in transit, if inside tag is not used.

If used bags are employed they should be turned inside out and thoroughly shaken to remove seed in seams which might cause an undesirable mixture.

Bags should be rolled and sewed properly at the top rather than tied.

Practice selection, breeding, and increase work to improve seed, or get seed stocks from the hands of able plant breeders.—The seed grower who follows effective methods of seed and varietal improvement, or who secures the best seed stock

obtainable, has a great advantage over the seed grower who neglects to maintain and improve his parent seed stock.

Without progress in improvement there is sure to be retrogression. "Run out" varieties are the result of carelessness in handling and in the neglect to select seed stocks properly.

FIG. 59.—The Right and Wrong Methods of Shipping Seed. The bag on the left is properly sewed, a better method than the tie at center. The bag at right ceases to serve its purpose when the corn cob comes out of the hole. (Courtesy of G. C. Edler, Bureau of Economics, U. S. Dept. Agric.)

A very few generations of failure to rogue fields and select superior seed stock for increase will result in the retrogression of excellent varieties.

Effective methods of breeding and improvement are discussed in Chapter III and are handled in detail with each crop discussed in the following pages.

CHAPTER V

GROWING AND MARKETING SEED CORN

The planting of good seed is the most important operation in the production of America's most valuable crop. Under present conditions, so large a number of corn growers plant seed of poor germination, improper adaptation, and low yielding ability that it may be safely said that more can be accomplished in cheapening the cost of producing corn and improving yields and quality by bettering the seed supply than by attention to any other factor, with the exception, possibly, of practicing methods which will check the corn-borer menace in states where this pest is established.

Producing high-class seed corn is no easy matter. In addition to securing or developing high-yielding varieties, the seed corn grower must master methods of harvesting, curing, and storing which will insure the ultimate delivery at planting time of seed of high germination.

Immaturity, high-moisture content and resultant damage from freezing and molds, heating of shelled grain, rodents and insect pests are factors which conspire against the producer of high-class seed corn and which are responsible for the comparatively inferior general run of seed which is the foundation of our annual crop.

For the seed-corn grower who masters modern corn breeding and selection methods, uses the best methods of production and harvest, and provides adequate facilities for safe curing, a splendid field exists both for local distribution and for the production of seed of ensilage corn for use in regions where seed cannot be safely matured.

Choose an adapted high-yielding variety.—The corn plant is so exceedingly variable and adaptable that myriad varieties have been developed for the extremely variable soil and climatic conditions existing over the great territory where corn is grown. Varieties adapted to the heart of the Corn Belt cannot be grown

FIG. 60.—This Seed-corn Grower has Developed a Convenient System for Taking Kernels from Numbered Ears for Making a Germination Test. The kernels from individual ear are placed in cup-like holes bored in a plank of soft wood for transference to germinator. (Courtesy of Paul Clement.)

with safety in either the northern or southern fringe of the present corn-growing territory. By proper slection of varieties, the spread of profitable corn-growing territory has been greatly extended to the North where shortness of season and resistance to cold are factors of primary importance, and to the West where drought resistance is of first importance. The variety selected

for any particular locality must be one that will fully utilize every day of the average growing season. To grow a variety too late in maturing means frequent loss due to failure to ripen; on the other hand, the growing of short-seasoned varieties in regions of average or long growing season results in a sure reduction of average yields.

Experimental work by the Ohio Experiment Station at the Corn Borer Sub-station at Bono, and by the Michigan Experiment Station cooperating with the Bureau of Entomology in work at the Monroe, Michigan, Corn Borer Sub-station indicates that quick-maturing varieties which can be planted late in the season may be utilized in more effectively growing corn where the corn borer exists. Such varieties may be in great demand over a wide area in a few years.

The table of varieties, page 417, shows some of the leading corn varieties for various corn-growing states and provinces.

FIG. 61.—The European Corn Borer Now Occurs in States Bordering Lake Erie and Eastward. It has done great damage to corn in Ontario. Seed corn cannot be shipped on the ear from quarantined areas and shelled corn shipped from these areas must undergo inspection. (Photo by Prof. R. H. Pettit, Dept. of Entomology, Michigan Exp. Sta.)

Follow best cultural methods.—The seed-corn grower is particularly desirous of securing a well-matured crop. He must plant his crop on sufficiently fertile, well-drained loam, silt, or clay loam soil for best results. A clover or alfalfa sod plowed in the fall, or, if fall plowing is not possible, in early spring, is a good foundation for a seed-corn crop. Old timothy or pasture sods are likely to be infested with white grubs.

The use of manure applied in the fall or during the winter, at the rate of from 4 to 6 tons per acre, gives excellent results. In addition, an application of 250 to 300 pounds of acid phosphate, applied broadcast, or with fertilizer attachment on drill, is effective in hastening maturity and increasing yields. A complete fertilizer, such as a 4–12–6, used at the rate of 250 to 350 pounds on soils somewhat depleted in fertility, will usually pay a good return to the seed-corn grower. The use of acid phosphate, or complete fertilizers high in phosphorus, frequently hastens maturity to the extent of a week or more.

Particular care should be taken in fitting the seed bed for planting by use of the disc harrow, spring-tooth harrow, spike tooth, and cultipacker. The finished seed bed should be firmly compacted in the lower part of the furrow slice and worked into fine tilth at the surface.

Planting should begin as soon as the ground is well warmed, early in the season rather than late.

Moderate amounts of seed should be used per acre—from 6 to 8 pounds in the Corn Belt and 8 to 10 pounds in northern corn states. The seed-corn crop is usually planted in hills 40 inches apart each way in central Corn Belt states, and 36 or 38 inches in northern regions or localities of high altitudes. Usually 2 kernels are planted per hill in the Corn Belt proper and 3 kernels in the northern fringe. If drilled, the rows should be 40 or 44 inches apart and kernels 14 or 16 inches apart in the rows in the Corn Belt. In northern states, the rows may be closer—36 or 38 inches apart with kernels dropped every 12 or 14 inches.

Hill planting is advantageous in that weeds may be more effectively and cheaply controlled by cross-cultivation.

The seed should be planted at a depth of from one-half to one inch, planting to the deeper depth on lighter soils or on dry seed beds.

After planting, the spike-tooth harrow or weeder may be effectively used before the plants show in the row. The first cultivation with the corn cultivator should be made as soon

as the plants are large enough so that the rows can be followed. Cultivator attachments of the blade or sweep type are most effective since they control weeds with a minimum of root pruning. From four to six cultivations are usually necessary in controlling weeds. It will pay to give more attention to the thorough cultivation of the seed crop than is usually given the average corn crop grown for feed or sale.

FIG. 62.—An Efficient Seed-corn Grader is Part of the Necessary Equipment of the Seed-corn Grower.

Harvest before damage by weather, particularly freezing, occurs.—The harvesting of seed corn as soon as the crop is mature, or when damage of freezing threatens, should not be delayed. After maturity, the risk of damage, and often actual damage, to seed condition increases daily. At time of maturity, the moisture content of corn as it stands in the field may range from 22 to 30 per cent or more. In this condition, corn kernels

are an ideal medium for the development of molds and, if exposed to heavy frosts or freezing temperatures, will be seriously damaged. Freezing and molds greatly reduce vitality, and seed corn must be harvested as soon as possible after ripening and placed under conditions for curing, which will dry the ears rapidly, reducing the moisture content to 14 per cent or less as soon as possible.

In harvesting the seed crop, best results are secured by plucking the well-matured ears from standing stalks, choosing ears from healthy, vigorous plants growing under average conditions.

If early frosts check growth before maturity, the crop should be cut and shocked, and after a week or more in the shock, husked and cured. If properly dried before exposure to freezing or to damage by the development of molds, seed corn of high viability can be secured from corn which failed to reach maturity and which may be in the "dough."

Large fields of seed corn may be husked by machine pickers to reduce costs. Machine-picked corn must be thoroughly worked over by hand, and diseased, off-type, immature, or otherwise undesirable ears discarded when the corn is placed on racks or hung on stringers in the curing house.

Cure immediately after harvest under conditions providing thorough ventilation.—As soon as harvested, ears selected for seed should be placed under conditions which will insure rapid drying without injury to vitality. A free movement of constantly changing air must take place around each ear to insure drying. Artificially heated air circulates more rapidly and extracts moisture more effectively than unheated air.

Many devices are in use for curing seed corn. Wire hangers made by cutting electric-welded steel fencing leaving stubs for ear-butts, are cheap and effective. Binder-twine hangers, hangers made by driving small-headed wire nails in wood strips, seed-corn trees, and patent hangers and racks are all effective means of keeping seed ears apart and providing conditions for a free movement of air during the drying period. The con-

struction of racks from 2 × 4's and lath, and the use of shallow crates with wire mesh or slat bottoms are employed by many good seed growers.

The seed-corn curing and storing house should be so constructed as to provide free ventilation, artificial heat when necessary, and protection from rodents and insects and weather damage. It should be so arranged that ears may be hung or

FIG. 63.—The Best Seed-corn Houses are Built on High and Narrow Lines, Two or Three Stories, Since Warm Air Rises More Effectively through Such a Building. An adequate system of ventilation must be provided. (Courtesy of Paul Clement, Britten, Michigan.)

racked at a minimum of expense and tested for germination and prepared for market with the least possible labor.

The ventilation system is of the utmost importance. Numerous ventilators must be provided both at top and bottom. Lower ventilators should be in the floor, or if in the wall, carried entirely to the floor so that pockets of dead or motionless air will not develop. The heating plant, stove, or furnace, should be located in a basement or on the lower floor. If

sufficient ventilation is not secured by heating the air, electric or motor-driven fans should be provided.

Air may be safely heated to a temperature of 109° F., though temperatures of from 80 to 100° are usually effective. Heat should be maintained for a sufficient period to dry the corn to a moisture content below 14 per cent. From several days to two weeks may be necessary, according to the adequacy of the ventilation system, the moisture content of the corn, and the humidity of the air.

Seed corn dried to a moisture content of 12 to 14 per cent is not injured by freezing and the development of molds and bacteria. Tests of moisture percentage should be made by the Brown-Duval tester, part of the necessary equipment of the seed grower. Seed corn should not be shelled for storage or shipment until the moisture content is below 14 per cent. Shelled corn at higher moisture content is frequently damaged for seed purposes by heating, molding, or sprouting, particularly as weather warms up in the spring.

The best seed-corn houses are built on high and narrow lines, two or three stories, with the heating plant in the basement, since warm air rises more effectively through such a building than it can be made to circulate through a long, low structure. The lower floor, or part of it, should be equipped with shelling, cleaning, and grading machinery and with germination testers.

One large seed house dries and cures seed corn very effectively by placing the ears on shallow crates with slatted bottoms. These crates are stacked one on the other, on a floor made of 2×4's set on edge one inch apart. Warm air is drawn through the floors of two stories of such construction by fans operating on the third floor. Furnaces under the first floor consume cobs from the shelled corn and warm the air carried up through the trays of corn. Three days of drying is usually sufficient to reduce moisture to the safety point for shelling and storing.

For curing seed corn in a small way on the farm, a well-ventilated attic or spare room in the house or barn may be used,

a stove being utilized for heating the air during years when seed corn does not thoroughly mature in the field.

After ears are thoroughly dried, they should be butted and tipped, shelled, graded, and bagged in strong bags of proper size for shipping. Peck, half-bushel, bushel, and two-bushel bags are generally needed in conveniently filling orders for a large clientele.

Seed-corn graders or fanning mills equipped with proper

FIG. 64.—Seed Corn Placed on Shallow Slat-bottomed Trays is Dried in a Current of Warm Air Drawn up from below by Fans on the Floor above. (Courtesy of Northrup, King & Co., Minneapolis.)

screens are used in cleaning and grading seed corn for shipment to the consumer.

Before shelling, a careful sort should be made and all diseased, discolored, off-type, or otherwise undesirable seed ears should be thrown aside. Large seed houses make the sort as the ears are conveyed to the drying crates on slowly moving belts.

Tests of germination should be made during the late winter

or early spring and before the ears are shelled. If necessary, an individual ear test should be made to insure seed which will give a test of 90 per cent or more. (See Appendix, page 439 for rag-doll tester.)

Seed dealers know the importance of prompt attention to orders. It is equally important for the farmer who wishes to develop a local or shipping seed-corn business to ship promptly,

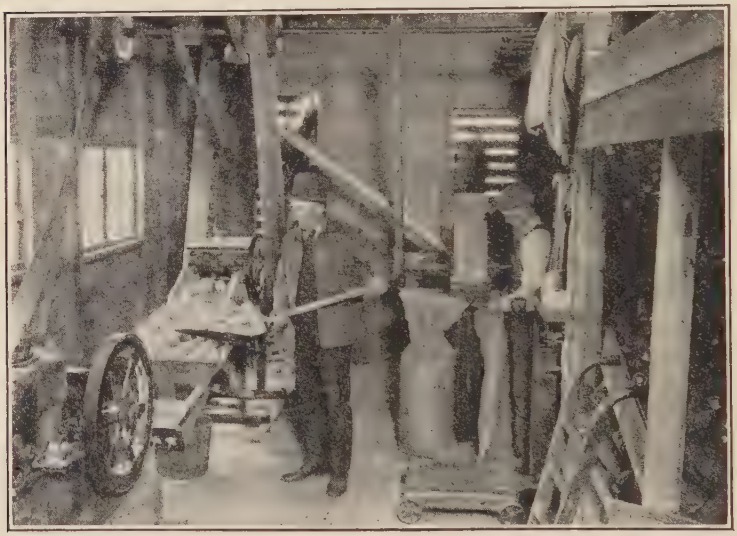

FIG. 65.—Shelling and Grading Seed Corn by Power-driven Machinery on an Indiana Seed-corn Farm. (J. C. Allen.)

use strong new bags, or, if seed is ordered on the ear, to ship in well-made and properly ventilated crates. Satisfaction on the part of the consuming grower is the best advertising, but the use of well-prepared advertisements in local newspapers, farm journals, farm bureau or other cooperative papers, during late winter and early spring, will help expand the market. The seed-corn grower who wishes to build up his clientele will also find it advantageous to take part in community or state corn-growing contests, enter exhibits at county and state corn shows

and become identified with his state crop improvement association or corn growers' association. (See Chapter III.)

Utilize or conduct breeding work to improve yield and quality.—The modern seed-corn grower should be familiar with the best methods of breeding corn, either to make use of the results of experiment station plant breeders or other efficient corn breeders, or in order to employ certain effective and practical methods on his own farm.

Varieties have been markedly improved by simple field selection, in which desirable ears have been chosen from healthy plants growing under average competitive conditions in the field. Care should be taken to select ears of proper maturity, placed at right height on the stalk with shanks which allow the ear to incline slightly when mature so that rain will drain toward tip of ear. After field selection, the ears should be carefully sorted and those selected for increase which are uniform in type, with well-formed large-germed kernels. Kernels of smooth or medium indentation indicate strains which will mature earlier than kernels with deep indentation or which are rough or chaffy at the crown. Such mass selection, continued year after year, effectively improves most varieties up to a certain point of yielding ability, uniformity of maturity, germination, and other characteristics. Diseased plants or ears should be avoided.

The ear-row method of intensified mass selection will get more rapid results than field selection. In this method, fifty or one hundred or more ears are carefully selected from standing stalks in the field. These ears are properly cured, numbered, and tested for germination. The ears of high test are butted and tipped and one-half of the ear is shelled lengthwise, the shelled kernels being placed in envelopes for planting and marked to correspond with the number of the ear. The half ears, unshelled, or " remnant ears " are wrapped in paper and placed in a wire-mesh bag for conservation until the following season. The shelled kernels are planted in an ear-row test, fifty hills being planted from each marked envelope and a stake

carrying the corresponding number placed at the end of the row. A composite sample made up of a mixture of a part of all ears included in the test, or of a tested number of similar ears, is used for planting two or more guard rows at the borders of the plat and as a check every fifth or sixth row in the test. All rows are given similar treatment in cultivating. At harvest time, the rows are harvested and weight of stalks and ears secured. The ears from each row are sorted to determine total weight of marketable ears and a moisture test made of each lot with the Brown-Duval tester. The best five or six rows are determined and the numbers noted. The next planting season, the remnant ears bearing these numbers are shelled and planted in a merging plat for increase, isolated 40 rods or more from other corn to prevent cross-pollination.

Fig. 66.—An Ear-row Test of Selfed Strains of Corn. The center row is characteristically weak-stalked. Such undesirable inheritance can be eliminated by modern breeding methods. (Photo showing Illinois Experiment Station Corn-breeding Work, by courtesy of *The Seed World*.)

The following season, the seed secured from this increase plat is increased on a field scale. Usually enough seed is secured from the merging and increase plats to plant 20 acres or more.

Improvement by use of the ear-row method is limited to a certain degree of effectiveness, but excellent returns are secured on varieties which have not undergone this method of selection.

The latest and most promising method of corn breeding consists of the self-pollination of a number of plants, for

several seasons, the progeny resulting being tested in an ear-row test, and the most desirable strains recombined to secure high yield and other desirable qualities. Such selfed and recombined strains are giving remarkable results, but yields fall off rapidly each year after the first generation. It is necessary that the desirable lines of parentage, two or four or more, be increased separately in isolated fields and brought together after increase in another isolated increase field.

By detasseling rows planted to one selfed or pure-line strain of parentage, alternated or intermingled with rows of one or more other pure-line strains, crossing is assured. Seed from the detasseled row carries the high-yielding ability desired. The crossings of the selected parents must be made each year from properly guarded increases of the selected selfed parent lines. Such intensified breeding work is now done by a few experiment station plant breeders. (See Chapter II.) A new and promising field is open for the seed-corn grower who will secure the proper lines of parentage for increase and recombination for sale of selfed and recombined lines. The public will soon demand and pay proper prices for such seed corn. Such a demand is now existent in Iowa, Ohio, Connecticut, and a few other states.

GROWING POP-CORN FOR SEED

Within the past few years, the use of automatic pop-corn machines in railroad stations, on street corners and other places where crowds congregate, has greatly increased the demand for pop corn. Formerly this demand was confined quite largely to home use—pop-corn around the fireside.

A great number of varieties were popular for the garden. Rice and pearl varieties of varying colors—yellow, red, blue, white, and mixed—were commonly grown. With the development of the commercial sale of pop-corn, a new variety—the Australian Hulless—has come into great demand. The Australian Hulless is rapidly supplanting the white rice formerly

used by the pop-corn trade. This variety pops more uniformly, has much less hull at the tip, and is an excellent yielder. It is also rapidly driving out, by its superiority in quality and yield, the numerous varieties of garden pop-corns.

The Australian Hulless is undergoing improvement at the Michigan Experiment Station and at the Arlington Sub-Station of the United States Department of Agriculture. It is quite variable and can be further improved by breeding.

In popping tests, it is shown that kernels that are clear, hard,

Fig. 67.—Sweet-corn and Pop-corn Seed, being Mature in Late Summer or Early Fall, is Often Cured in Narrow Wire-mesh Cribs, Covered with a Tar-paper Roof.

and vitreous are the best. Ears carrying such kernels should be selected for seed. It is important also to select kernels that have thin hulls and thin chaff at the tip.

In making pop-corn tests, the corn should be dry enough to pop thoroughly but not too dry. Pop-corn should be stored under conditions of average atmospheric humidity. House storage will make it too dry to pop. A sample kept in the kitchen, for instance, for a long time, will often improve greatly in popping qualities when placed on the back porch for several days.

In handling seed pop-corn, selections should be made as soon as the crop is mature, following the same method advised for the handling of sweet-corn seed. The ears should be dried quickly and placed under conditions where they will not be damaged by freezing weather, insects, or rodents. The demand for improved seed is sure to increase with the greater use of pop-corn.

GROWING SWEET CORN FOR SEED

Sweet corn for use as a fresh vegetable and for canning has increased greatly in importance with the development of improved varieties during the past ten years. During the War period, the home-garden movement popularized the Golden Bantam as a variety for the table. This variety, which formerly sold with difficulty, because of its yellow color, is to-day the outstandingly popular garden variety and meets with ready sale on most markets. Other varieties of importance for sale on the ear are the following: Alpha and Earliest of All—both exceedingly early varieties; Mammoth White Cob Cory, the best large-eared early corn; New Sunshine, also early; Howling Mob, for midseason, Stowell's Evergreen for late season.

For canning purposes, the Golden Bantam has also become a popular variety owing to its sweetness and delicacy of flavor. While it does not yield as much as many others, the demand for this variety by the public has caused it to become a very important canning variety. It is used both alone and with beans in canned succotash. Other important varieties are: Stowell's Evergreen, a medium to late type; the Crosby, second in quality and flavor to the Golden Bantam, a higher-yielding medium early type; the Shaker and Hickox which continue to be of some importance for canning. Of the Evergreen varieties, the "Shoepeg" or narrow-kernel type, which is cut two or three times in the process of canning, is of more importance than the tougher-skinned broad-kerneled Evergreens. The Country Gentleman is an important late canning variety of high quality.

In growing a seed crop of sweet corn, it is important that a

well-matured, high-yielding crop be secured. A fertile loam, clay loam, or sandy loam should be selected, manure applied in the fall or early spring, and ground plowed to good depth in the fall or early spring. The seed bed should be worked thoroughly and 300 to 500 pounds of acid phosphate or of a complete fertilizer high in phosphorus added. Planting should be made when the ground is well warmed, and thorough and frequent cultivations should be given. The seed crop should be isolated from other corn fields. A distance of 40 rods reduces danger of crossing to a slight possibility.

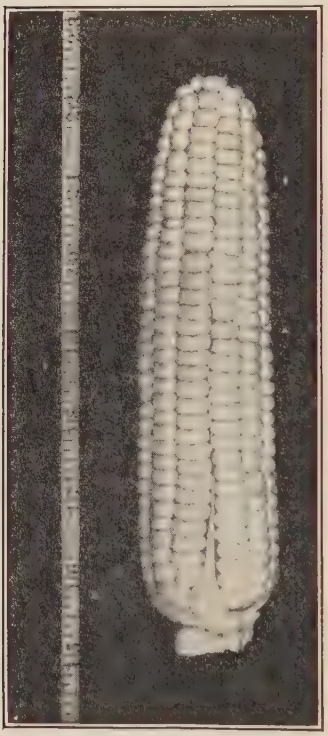

Fig. 68.—A Good Seed Ear of Mammoth White Cob Corey, the Best Large-eared Early Sweet Corn.

In harvesting seed, it is of the greatest importance that sweet-corn seed be harvested as soon as ripe. Every day that ears are left in the husk means deterioration in seed value. Molds develop quickly in sweet corn, and even though not exposed to damaging freezing weather, ordinary field exposure in the husk will greatly damage the seed. As soon as mature, the ears should be harvested and placed on drying racks properly hung in a well-constructed seed-corn house.

Since sweet corn for seed is often ready to harvest in late summer and very early fall, some growers secure good results by husking and curing the seed in long, narrow, out-door cribs protected by tar-paper roofs. Free passage of air through these

cribs at that season of the year rapidly dries the corn. Before freezing weather, it is moved into storage.

Good seed of sweet corn should be firm, dry, vitreous or glassy in appearance and of high germination. Selection or

Fig. 69.—Typical Ears of Country Gentleman Sweet Corn, an Important Late Canning Variety of High Quality.

breeding methods similar to those recommended for field corn will give effective results with sweet corn. The type desired for the variety or for the particular use of the corn must be understood. High sugar content is necessary, and in selecting or breeding sweet corn, ears carrying much-wrinkled vitreous

or " glassy " kernels should be selected. There is a correlation between the fine wrinkling on surface of kernel and per cent of sugar content. The taste will also serve as a useful indicator where chemical analyses of sugar content are not made. The maturity, yielding ability, and quality of sweet corn can be controlled by breeding.

GROWING THE SORGHUMS FOR SEED

In semi-arid regions the **Grain Sorghums** form the basis of livestock feeding industries. They have the ability to withstand drought and hot weather to a greater extent than

FIG. 70.—A Seed-corn-curing House of Three-hundred-bushel Capacity. A single flue or pipeless furnace in basement provides circulating warm air. (R. Arbogast, Michigan.)

corn, and are of importance in the drier regions west of the Corn Belt. Kaffir, Durra, Milo, Shallu and Kowliang are the leading grain sorghums.

In planting for seed, 8 to 10 pounds per acre are drilled in rows 42 to 44 inches apart on a seed bed prepared as for corn.

The lister is generally used. The ground should be thoroughly warmed up at planting time, planting dates for various regions coming a little later than corn-planting time. Thorough cultivation is given as for corn. During favorable seasons yields range from 40 to 60 bushels or more per acre of seed.

Of the sweet sorghums, the Early Amber and Sumac are leading varieties. These are grown for syrup and forage purposes throughout the central, southern and western part of the Corn Belt, the Early Amber being important in the northern

FIG. 71.—Harvesting Grain Sorghum in Western Kansas. (Courtesy of *The Seed World.*)

central regions and the Sumac in Texas and other Southern States.

Broom corn is a type of sorghum grown for its stiff-strawed panicle. The Dwarf Broom corn is most largely grown in Kansas and Nebraska, and the mammoth or large type broom corn in Illinois. Seed is planted at the rate of 3 to 5 pounds per acre in rows 36 inches apart for the Dwarf and 42 inches for the large type.

The crop is cultivated in a similar way as for corn. When the seed is in the dough the stalks of two rows are bent together or

"tabled" and the panicles carrying the seed cut from the stalk with a corn knife. The seed is stripped from the panicles by inserting in a stripping machine.

Seed yields of 15 to 25 bushels per acre result during good seasons on good land.

Much improvement in type of broom straw secured has resulted from careful selection of panicles having the longest and straightest broom straws.

Sudan Grass is grown chiefly in Kansas, Nebraska and Texas for seed purposes, though it is important throughout sorghum-growing regions. In Texas and other Southern States, great care must be taken in growing Sudan grass seed in soil free from Johnson grass. The seed of Johnson grass is very similar in appearance and this tenacious perennial pest is often spread by seeding Sudan grass mixed with Johnson grass in southern states. The production of certified Sudan grass seed guaranteed to be free of Johnson grass is important in Kansas. During the past few years immense shipments of Sudan grass seed have been made to Soviet Russia. For seed purposes, it is planted at the rate of 3 to 5 pounds per acre in rows 36 inches apart and given several cultivations. The crop is harvested with a binder, cured in uncapped shocks in the field and threshed with a common grain separator.

CHAPTER VI

PRODUCING SMALL GRAINS FOR SEED

It is the common practice of possibly 80 per cent of the growers of wheat, oats, barley, and rye to reserve a portion of their general market crop to provide for their planting needs the following season. Not more than approximately 8 per cent of the total seed planted of these small grains is handled by the established seed trade. From 10 to 15 per cent is handled by farmer seed-growers who sell seed to neighbors or to a small clientele.

Owing, however, to the enormous total acreage of the small grains, the total value of small-grain seed handled by the seed trade, though the percentage is small, is greater than the values of the seed handled of any other four crops.

The demand for high-quality seed of high-yielding, disease-resistant varieties is increasing, particularly for seed produced locally; and an annually increasing percentage of small grain seed can be expected to be produced by farmer-growers who specialize in producing seed for local distribution.

The particular soil and climatic adaptation of varieties of wheat, oats, barley, and rye, and their bulkiness and, hence, expense in shipment, are sound reasons for the development of local distribution. Serious seed shortages of these grain crops are very infrequent since the main market supply can be drawn upon. Seed prices also are kept comparatively low, owing to large existent supplies of market grain.

There is a strong tendency, however, to pay adequate prices for good seed of high-yielding varieties.

The day is rapidly passing when farmers pay exorbitant

prices for seed of "wonder" varieties from distant climes. Careful growers prefer to try out new varieties in a small way and secure seed of known adaptation and value for their main crop.

The best variety for his locality should be grown by the seed grower.—The main market classes of wheat are grown in more or less well-defined areas of adaptation.

FIG. 72.—A Seed Field of Marquis Spring Wheat. This variety has added greatly to the producing power of Canadian and Northwestern spring-wheat districts. (Photo by courtesy of *The Seed World*, Chicago.)

The hard red winter wheat of Kansas is not adapted to Ohio or Michigan where semi-hard or soft wheats are grown. The club wheat of the Palouse gives sorry yields in the spring-wheat region of the Dakotas. Durham wheat will not yield well in the Corn Belt. There are a great number of varieties of each of these main classes and a great variation exists in the

yielding ability, quality, disease resistance, and particular adaptation of these varieties. It behooves the seed-wheat grower to secure, by test, observation, and information from dependable sources, the best variety for his farm and clientele.

The Kanred wheat of Kansas, resistant to black stem rust, is a great variety in that state and similar adjacent regions.

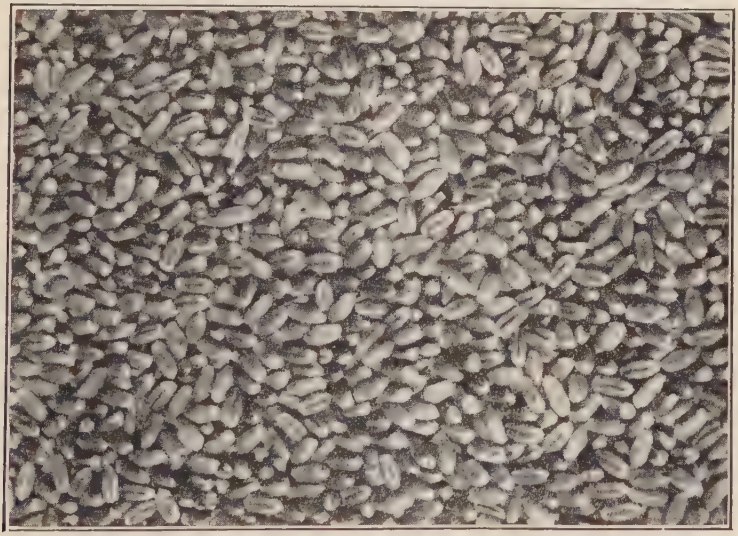

FIG. 73.—A First Prize Sample of Spring Wheat at the Chicago International Grain and Hay Show, 1926. This great competitive exhibition of seed, grain, and hay has become an annual fixture at the famous International Live Stock Show.

The Marquis spring wheat of Canada and the Northwest, the Federation wheat of Oregon, the Gladden of Ohio, the Red Rock of Michigan, the V. P. I., No. 131, of Virginia, the Poole of Indiana, the Turkey Red of Illinois are examples of varieties in great demand and of great worth.

On page 417 is given a list of wheat varieties of known worth, developed, for the most part, by Experiment Station plant breeders.

The use of the most effective cultural methods is important to the seed-wheat grower. Seed wheat, either fall or spring planted, should be treated to prevent stinking smut (see formaldehyde and copper carbonate treatments, Appendix, pages 424, 425). If loose smut was present in the previous crop, new seed from clean fields should be secured or the hot-water treatment for loose smut employed. (See Appendix, page 426.)

The seed bed for wheat should be firm and well surfaced. Early plowing, followed by the use of the disc, spike-tooth, and cultipacker, is necessary in preparing the best type of seed bed.

Moderate rates of planting give plumper kernels; 4 or 5 pecks per acre of spring wheat, and 5 or 6 pecks of winter wheat per acre is sufficient.

The use of 200 to 300 pounds of acid phosphate per acre or of a complete fertilizer, such as a 4–12–4, is effective in increasing yield and hastening maturity, and a plumper, heavier grain results. Phosphate fertilizers are particularly effective on the phosphate-hungry soils of the humid areas of the United States.

Three or 4 tons of manure per acre worked into the seed bed paves the way for increased yield and quality, when applied in addition to the acid phosphate.

Light top dressing with straw or manure in late fall or early winter aids in preventing winter killing and in moisture retention.

In spring, harrowing lightly with the spike-tooth or going over with the cultipacker may prove profitable where heaving, due to winter action, is noticeable.

Harvest seed wheat as soon as mature.—It is particularly important that wheat intended for seed purposes be bright in color and unimpaired in vitality. The risk of possible weather damage increases with every day mature wheat stands in the field.

As soon as kernels are in the tough-dough stage, harvest should begin. This condition is indicated by pressing between the fingers. When the kernels are not easily disrupted by pressing between the thumb and forefinger, but easily take the

print of the thumb nail, the crop is in an ideal condition for harvest.

Most seed-wheat growers find it advisable to store sheaves for thrashing in the mow or in well-made stacks as soon as they have cured sufficiently in the field. Usually several days in the shock are sufficient.

Seed wheat threshed from the mow or stack in mid-western and eastern and other humid areas is, of course, not exposed to the damage from weathering which may occur to wheat in the

FIG. 74.—Plump, Well-matured Seed Wheat (shown at *left*) Germinates Better and Produces Thriftier Plants than Shriveled Immature Seed (as shown at *right*). (Photo by Allen.)

shock, and a brighter, cleaner seed of higher germination is secured.

Threshing from the stack or mow may be done at any convenient time, but in the case of winter wheat it is usually advisable to thresh comparatively soon after harvest so as to take care of early orders.

If an itinerant thresher is used, care should be taken to clean all ledges and corners inside the separator, to prevent mixing. This may require an hour or so of time, but is worth while. The first run of 25 bushels or more should be taken

aside and used for feed. Some prefer to thresh oats first so as to insure freedom from other winter wheats.

Many seed-wheat growers find it advisable to own their own separator so as not to run the risk of mixing other varieties with their seed wheat. Small types of separators, run by 6 or 8 horse-power gas engines, or tractor power, are used by seed growers having a moderate acreage.

Clean seed wheat after threshing with an effective fanning

FIG. 75.—Small Grain Seed Growers Will Find it Profitable to Own Their Own Grain Separator. Mixtures with other varieties which commonly result when itinerant threshers are used, are prevented. Threshing can be done when the crop is in best condition or when most convenient. (Photo taken at Arbogast Seed Farm, Union City, Mich.)

mill. Dirt, chaff, broken and light kernels, and weed seeds which escaped rogueing are almost entirely removed by thorough fanning. Such weed seeds as garlic, wild onion, chess, and vetch may not be completely removed, and if they are present beyond a trace, such wheat should not be used for seed purposes.

Growers who specialize in seed-wheat production find that much time and expense are saved if conveyor chutes are arranged

to carry the cleaned seed from the fanning mill directly into the storage bins.

Seed wheat should be stored in tight, vermin-and-insect-proof bins. Bottom chutes should be so arranged that sacks can be conveniently filled. In regions where the angoumois moth or other grain insects cause damage, the carbon disulphide treatment should be employed. (See Appendix, page 432.) Tight bins are essential for the effective use of carbon disulphide.

Shipments of seed wheat should be made in tight, strong bags properly sewed at top.

Maintain breeding work and increase fields for improvement.—Most seed-wheat growers will get best results by securing "elite" or "registered" seed of improved varieties from Experiment Station plant breeders or from dependable growers of high-grade parent seed stocks. If enough seed is not secured for planting the entire crop, increase fields of several acres or more should be planted and harvested and threshed separately for extensive planting the following season.

The selection and increase of heads from plants that appear promising is to be encouraged among seed-wheat growers. Many varieties have been developed in this way.

Plants that tiller or stool abundantly, have stiff straws, well-filled heads, and kernels of unusual hardness and translucency in the case of bread wheats, and show no indication of loose or stinking smut should be selected and planted in a separate place in the garden or field. Such small beginnings can be threshed by hand for planting the next year. The larger increase the next year can be harvested with a cradle, scythe or sickle, and threshed with a flail, if available, or by beating a sack filled with the heads with a round stick. The chaff can be windrowed on a tarpaulin in the open air, or cleaned with a fanning mill. When enough seed is secured to plant an acre or so, the increase field should be isolated and handled separately from other wheat or rye. Threshing after oats prevents mixing with other winter wheat varieties and enough

seed results for extensive planting. Plant breeders use specially constructed small threshers and separators for threshing grain from small plats.

By head or plant selecting in the field, improvement can often be accomplished with many varieties that are not pure lines. Pure-line varieties that have become mixed can be purified by head or plant selection. Several bushels of heads should be gathered from thrifty well-stooled plants of similar

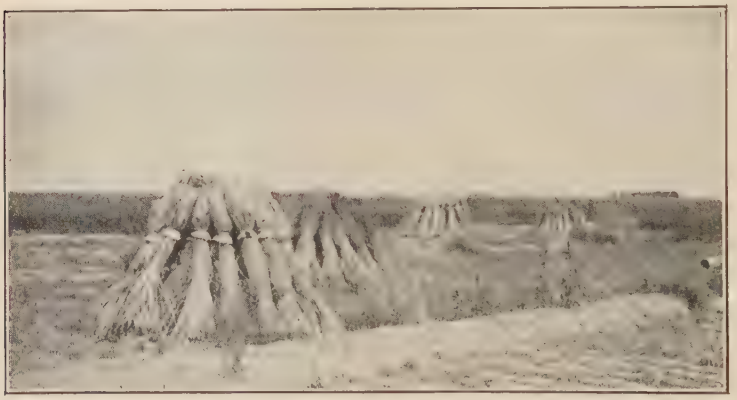

FIG. 76.—Individual Strains of Wheat Harvested Separately and Protected with Paper Bags. A method employed by wheat breeders in the drier western regions. (Photo taken at Aberdeen, Idaho, Small Grain Experiment Station.)

characteristics. A bucket or small basket is a convenient carrier. The heads so selected are threshed and planted in an increase field of one or more acres in order to secure a substantial amount of the improved or purified seed for extensive planting.

GROWING SEED RYE

Rye is chiefly grown for grain in the northern tier of states and in Canada. It is extensively used, however, in the South as a cover crop and pasture crop.

Being open-pollinated, rye varieties mix readily, and until recent years, the commonly grown rye showed little uniformity in type, and was largely unimproved by breeding.

At the present time a number of excellent varieties are in widespread use. In Michigan and in a belt including the northern part of the Corn Belt and extending to Oregon on the west and New York on the east, the Rosen variety is the most widely grown. This variety was developed by the late Professor F. A. Spragg, from selections of seed brought from Russia by J. A. Rosen. The first field releases were made from the Michigan Experiment Station in 1912. Through the agency of the Michigan Crop Improvement Association, large quantities of high-grade certified seed of known purity were made available to the public. The association maintains strict regulations in regard to purity, requiring that certified seed rye be grown at a distance of at least 40 rods from other rye fields to prevent the likelihood of cross-pollination.

Special breeding work is carried on in cooperation with members of the Michigan Crop Improvement Association located on the South Manitou Island, Michigan.

All rye grown on this island is improved Rosen. Annual selection work followed by field increase is maintained each year. The island rye serves as a source of registered seed for other growers of certified seed rye. During the past seven years the first prize at the Chicago International Grain and Hay Show has been won six times by island growers, a Canadian-grown sample of Rosen winning in 1922.

In Wisconsin, the Wisconsin Pedigree Rye, developed at the Wisconsin Experiment Station, is recommended to growers; and in North Dakota, the Dakold, and in New York, the Heinrich and Rosen. In the South, the Abruzzi is the best adapted variety, giving a greater top growth for pasturage and for turning under. Spring Rye is grown to a slight extent in the Northwest and Canada.

In growing seed rye it will pay to plant sufficiently early for a good top growth to develop, usually when fall wheat is

FIG. 77.—The South Manitou Island in Lake Michigan, Ten Miles off the Leelanau Peninsula, is Famous for the Production of Rosen Rye under Conditions where Cross-pollination and Mixing are Prevented. The Michigan Experiment Station has maintained cooperative selection work with growers for the past eight years.

FIG. 78.—George and Louis Hutzler, Island Rye Growers, have Won First Prize on Rye at the Chicago International Grain and Hay Show Five Times in the Past Seven Years.

planted or shortly after. The crop should be planted on a well-prepared seed bed, acid phosphate and manure or a complete fertilizer being used as advised for wheat. One bushel per acre of seed is ample and will give better filled heads and plumper kernels.

The field should be isolated by at least 40 rods from other rye fields to prevent crossing, and all volunteer rye kept down.

Vetch, chess and other weeds should be rogued from the field before threshing. If ergot develops to the point where

FIG. 79.—Rye Cross-pollinates Easily and Improved Varieties Must be Isolated from Other Varieties in Order to Maintain Purity. Rosen Rye at *center*; Common and Rosen Cross at *right*; Common Rye Heads at *left*. (Michigan Exp. Sta.)

it is noticeable in the seed, a new start with ergot-free seed should be made or the seed carefully cleaned by the salt solution method. (See Appendix, page 438.)

Rye is harvested and threshed in much the same manner as wheat, except that it is cured in the field in uncapped shocks.

Maintain selection work.—It will well repay growers who specialize in seed-rye production to head-select sufficient seed for increase plats of $\frac{1}{2}$ or 1 acre or more, which will furnish enough seed for the next season's planting on a field scale. At time of harvest, select large well-filled heads from plants which

are healthy and stiff-strawed, and tiller or stool vigorously. These heads may be collected in a bucket or basket. They should be spread out thinly to cure and may be threshed by placing in a grain bag or gunny sack and beating with a stick. The chaff may be effectively removed with a fanning mill. Enough seed should be collected to plant $\frac{1}{2}$ or 1 acre (2 to 4 pecks). The increase plat should be removed by about 40 rods or more from other rye to prevent mixing. The next year 20 or 30 bushels or more of seed should be available for extensive field planting. Such work, kept up year after year will result in improvement in yield and uniformity

GROWING SEED OATS

Oats vary greatly in adaptation. In the Northern States and Canada, the leading oat-producing regions, comparatively long-seasoned white spring-planted varieties, requiring from 85 to 110 days for maturity, are grown. In the Corn Belt, where hotter summer weather prevails, shorter-seasoned oats, requiring 60 to 75 days, are usually grown since they mature before the extreme heat of summer. Many of these early varieties are yellow in color. In Texas and other Southern States, winter or fall-planted oats are commonly grown.

Some of the outstanding oat varieties are the Swedish Select, Silver Mine and Victory of Northern States; the Wolverine and Worthy of the Michigan Experiment Station; the Wisconsin Pedigree of Wisconsin; the Kanota of Kansas; Iowar of Iowa; and the smut-immune Markton [1] of the Washington Experiment Station. See Appendix, pages 417 to 424, for recommendations of leading varieties by states.

The seed-oat crop of the Corn Belt and Northern States should be planted on ground free of Canada thistles, wild oats, wild buckwheat, kinghead, mustard, wild onion or garlic, or other weeds which set seed when oats mature, and which are separated with difficulty.

[1] According to Prof. G. R. Hyslop and Mr. T. R. Stanton of the Oregon State Agricultural College, the Markton oat is immune to covered smut of oats, and is highly resistant, if not immune, to the loose smut.

The seed bed should be fall-plowed or spring-disked land, preferably following a cultivated crop. In corn borer-infested areas fall or spring plowing to cover corn stalks or complete destruction of stalks, is necessary in fitting corn ground for oats. The land should be firmly compacted with roller or cultipacker and the oat crop planted as early in the spring as it is possible to plant, using from 6 pecks to 2 bushels per acre of seed. The lighter planting gives plumper kernels. Acid phosphate should be applied at the rate of 200 to 300

Fig. 80.—A Foundation Stock Field of Seed Oats, Grown for Substantial Increase for Dissemination to Parent Seed-farms of Crop Improvement Association Growers as "Elite" Wolverine Oats. (Michigan Exp. Sta.)

pounds per acre, or a complete fertilizer high in phosphorus used. Seed should be treated with formaldehyde to prevent smut, note Appendix, page 425.

Before harvest the crop should be rogued of thistles, buckwheat, dock, and other weeds. Particularly weedy portions should be drawn aside and threshed after the seed crop.

Harvest should begin when the oats are in the dough. After curing in the field the sheaves should be stacked in well-

made and properly capped stacks, or placed in the barn or under roof so as not to be discolored by weathering.

A premium is placed on bright color and high germination. The seed should be stored in tight, well-ventilated bins where it will not mold or be damaged by heating in the bin.

GROWING SEED BARLEY

Barley has been increasing steadily in acreage and in use for feeding purposes during the past ten years. It is very likely that demands for seed barley will markedly increase in regions where the corn borer may make corn production for grain unprofitable or where it may be advisable temporarily to reduce corn acreages. The barley crop is particularly well adapted to the Northern States and Canada and to the irrigated regions of the West.

Many types are grown. In the Northern States and Canada, the six-row and two-row hulled types are most common. In the irrigated regions hulless barley is a leading type. In California two-row hulled types are commonly grown. The hooded or commonly called beardless types are preferred where barley is fed in the sheaf. A smooth-awned or smooth-bearded black barley, developed at the Michigan Experiment Station has been in production for a number of years in that state and smooth-awned white barley strains have recently been developed at the Minnesota Experiment Station, at the Michigan Station, and by the United States Department of Agriculture.

The leading varieties as recommended for various states and provinces are given on pages 417 to 424. Some of the outstanding barley varieties are the Oderbrucker of Canada, and the Northern States, the Wisconsin Pedigree of the Wisconsin Experiment Station, the Alpha of the Cornell Station, the Beldi Giant of Washington, Trebi barley of the Idaho Experiment Station, and of South Dakota. All of these are spring-planted barleys.

Winter barleys are of importance in Maryland, Virginia, and a few states south of the Ohio River.

Growing the barley seed crop.—Spring barley should be planted in early spring in a thoroughly fitted, well-compacted seed bed. The seed should be treated with formaldehyde to prevent covered smut and the barley stripe (see page 425). Six pecks per acre is sufficient seed for the best seed crop. Acid phosphate or a fertilizer high in phosphorus gives excellent results on most soils. Before harvest, the crop should be rogued of weeds such as Canada thistle, vetch, wild oats, and kinghead. The barley crop should be harvested in the tough dough stage, cured in uncapped shocks, stacked in well-made stacks or in the barn until threshed. Attention to the securing of the best available seed stocks and to the maintenance of selection work, as for oats, will maintain a high standard of purity and frequently accomplish improvement.

FIG. 81.—The Late Plant Breeder, F. A. Spragg, Hybridizing Barleys in the Effort to Produce an Improved Strain of Smooth-bearded White Barley. (Michigan Exp. Sta.)

BUCKWHEAT

While of minor importance as a grain crop, buckwheat is grown over a wide area as a grain crop, honey crop, cover crop and green manuring crop. It is often employed as an emer-

gency crop to be grown where other crops have failed or planting has been delayed until too late for their success.

The Japanese, Silverhull and Gray are the leading varieties. The Japanese is the largest growing type and produces heaviest yields except under conditions of unusual drought at blossom time, when the Silverhull is superior.

Best results are secured with the seed crop by planting buckwheat in a well-fitted seed bed prepared and fertilized as for oats or barley. The planting should be made when the seed bed is well warmed, in late May or during June, using 3 or 4 pecks of seed per acre.

Since the blooming period of buckwheat is indeterminate, judgment must be employed in harvesting when the majority of the seed is ripe and before great loss occurs from shattering. A mower with buncher attachment, used in early morning or on damp days, does the best job of harvesting. Buckwheat is cured in the field in small uncapped shocks. Threshing is done with an ordinary grain separator, yields of from 20 to 35 bushels generally resulting.

GROWING SEED OF SEED-FLAX AND FIBER-FLAX

Seed-flax is an important crop in the Northwest and in Canada, though in recent years its production is being undertaken in Wisconsin and northern Michigan. The growing of fiber-flax, a longer-stemmed variety, is limited to a small area in the Thumb of eastern Michigan, an adjoining region in Ontario, and a small territory in Oregon.

In growing **seed-flax**, a wilt-resistant variety such as the North Dakota Linota, should be secured. The seed should be treated with formaldehyde (see page 425). Planting should be done in early spring on a well compacted fall- or early spring-plowed seed bed. Usually 2 pecks per acre are drilled with an ordinary grain drill. The crop is harvested when the seed balls are brown and eight or ten seeds are developed in each ball. A grain binder is used in harvesting and the seed

cured in open shocks in the field or under dry conditions, threshed immediately, using a common grain separator equipped with flax screens. Yields of 14 to 18 bushels per acre are considered excellent.

Of **fiber-flax,** the Saginaw variety developed at the Michigan Experiment Station by the office of Fiber Investigations of the United States Department of Agriculture, is recognized as one of the best varieties. The fiber-flax crop is usually planted at the rate of 2 bushels per acre in well-fitted loam or clay loam.

The crop is harvested by pulling by hand or by machine when the seed-balls are formed and beginning to turn brown. It is cured in the field in open shocks, and the seed is removed by a special hand thresher which strips the seed without injuring the fiber. The stems are then spread out for retting. Seed yields of 6 or 8 bushels per acre are usual from good crops of fiber-flax. A good export market exists for the seed of the Saginaw and other improved American fiber-flax varieties.

CHAPTER VII

PRODUCING SEED OF THE CLOVERS

The clovers rank among the most valuable legumes grown in meadows for the production of a high-protein hay or in pastures for their enrichment for grazing purposes, and included in rotations for the maintenance and increase of nitrogen and organic matter in the soil.

Red clover is of greatest importance in the Corn Belt, the Northern and New England States and in the extreme Northwest. It has often been termed a foundational crop in Corn Belt rotations. Being a biennial, it is adapted to seeding with oats or barley or on wheat and rye, producing a hay crop and pasture crop or hay and seed crop the following year. A clover sod has long been recognized as an ideal foundation for large crops of corn, potatoes, or other cultivated crops following the clover. Red clover thrives best on soils well supplied with lime and will not give profitable results on acid soils.

Mammoth clover is very similar to red clover. In fact, it is very likely a giant species. It gives but one satisfactory hay or seed crop the year after seeding. Mammoth clover gives a taller and coarser growth and is usually two or three weeks later in maturing than the red clover. The seed is identical in appearance.

Alsike clover is most largely grown in the Northern States and in Canada. It is more tolerant to extreme cold and to acid and wet-soil conditions. Alsike is commonly planted on soils that have become too acid for profitable red-clover growing in the Corn Belt and central Southern States. It is also widely used in meadow and pasture mixtures.

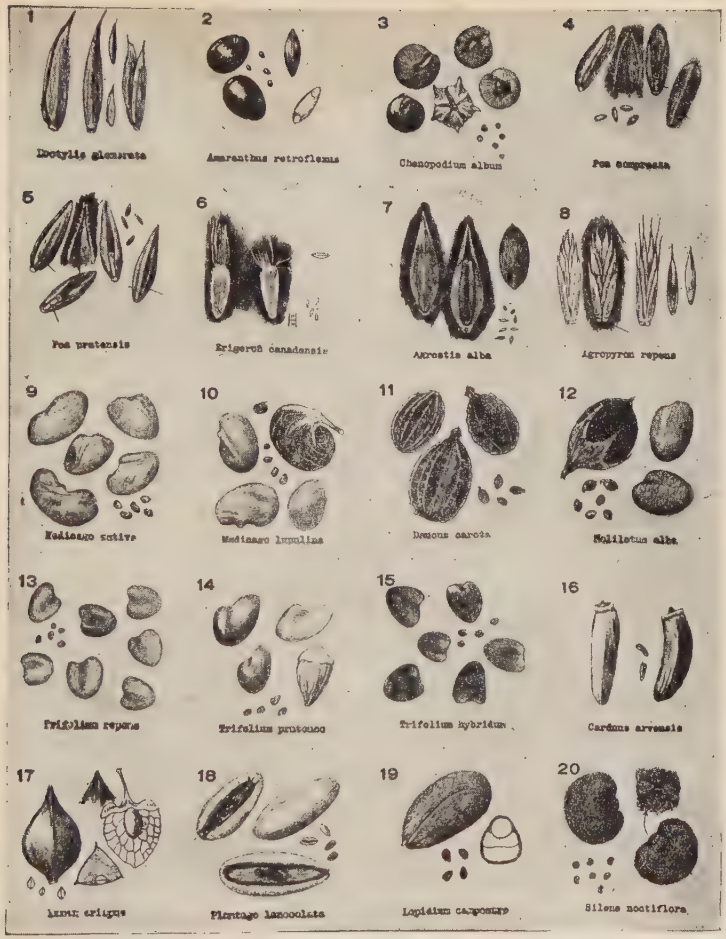

FIG. 82.—Illustrations of the Seeds of Twenty Plants Often Associated with Clover Seed. From the U. S. Dept. Agric. Seed Laboratory.

1. Orchard Grass
2. Rough Pigweed
3. Lamb's Quarters
4. Canada Blue Grass
5. Kentucky Blue Grass (June Grass)
6. Horse Weed
7. Redtop
8. Quack Grass
9. Alfalfa
10. Black Medic or Yellow Trefoil
11. Wild Carrot
12. White Sweet Clover
13. White Clover
14. Red Clover (June Clover)
15. Alsike Clover
16. Canada Thistle
17. Curled Dock
18. Buckhorn
19. Field Pepper Grass
20. Nightflowering Catchfly (sticky cockle)

Farmers should be familiar with the appearance of the clover seeds and the common weed and grass seeds which are frequently found in clover seeds. By spreading a teaspoonful of seed on a white paper and making a careful examination, the presence of such harmful weed seeds as buckhorn and curled dock in red clover, and the night-flowering catchfly and pepper grass in alsike can be determined.

White or Dutch clover is used almost entirely in pasture and lawn-grass mixtures. It has an exceedingly wide range of adaptation, being grown throughout the Corn Belt, northern and eastern territories, and well into the central south. White clover prefers soils well supplied with lime and its abundance in pastures is taken as an indication of a fertile soil naturally well supplied with calcium carbonate. It is perennial in growth.

Ladino, a legume very similar in appearance to white clover but making a taller and more luxuriant growth, has achieved some importance in Idaho. This legume was introduced into the United States from Italy through Mr. E. M. Westgate of the Office of Clover Investigations of the Bureau of Plant Industry, United States Department of Agriculture. A Ladino seed association has been formed in Idaho for the production and distribution of this seed under a system of inspection and certification.

Crimson clover is grown chiefly in New Jersey, the south Atlantic seaboard and Gulf States, and in the southern part of the Corn Belt. It is fairly acid-tolerant and is annual in its habit of growth. It is used chiefly as a hay, pasture, and green-manuring crop.

GROWING RED CLOVER FOR SEED

Choose an adapted strain.—Great variations exist in the winter hardiness, disease resistance and yielding ability of red-clover strains from various localities. Generally speaking, red-clover seed from strains that have been known to produce profitably in a particular locality for a number of years are best suited for seed purposes in that locality. Seed of the Corn Belt and Northern States is apparently interchangeable over a wide territory in these great regions. In Tennessee, a strain known as the Tennessee disease-resistant red clover, developed at the Tennessee Experiment Station and resistant to clover anthracnose, gives best results. Idaho and Minnesota-grown seed is fairly well adapted to the Corn Belt and Northern States, but at several experiment stations has not per-

formed as well as seed produced in the immediate locality of the respective stations. Oregon seed, produced in the milder regions of Oregon, has shown lack of hardihood when grown in comparative tests in several Corn Belt and Northern States.

During the past decade, tremendous loss has been caused to

FIG. 83.—Strains of Red Clover from Various Sources Vary Greatly in Their Adaptation. The test above illustrates comparative results at the Arlington, Virginia, Experimental Farm of the United States Department of Agriculture.

Center: Tennessee
Left: Italian
Right Bohemian

(Courtesy of Dr. A. J. Pieters, in charge of Clover Investigations, U. S. Dept. Agric.)

American agriculture by extensive importations of Italian red-clover seed which has been proven to be worthless in clover-growing areas of the United States. The Italian red clover is very susceptible to winter killing and to injury from anthracnose and other fungous diseases.

French red-clover seed, also largely imported, is quite generally not as satisfactory as locally grown domestic seed. The

second crop of French red clover is usually very sparse, providing an unsatisfactory growth for pasture or seed purposes or for turning under; the heads of French clover are very small and carry little or no seed.

The French and Italian clover plants have smooth or appressed hairy stems while native plants have hairy stems.

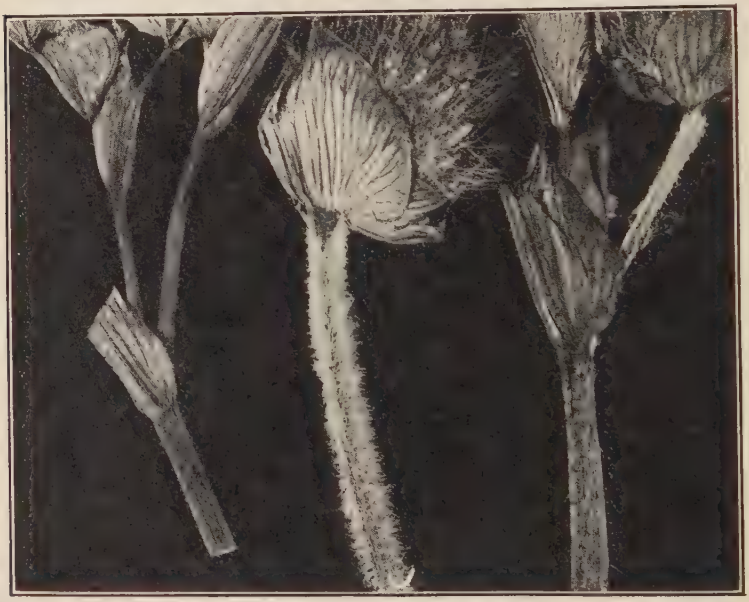

Fig. 84.—(*Left*) Italian Red Clover; (*center*) American Medium Red Clover; (*right*) English Broad Red Clover, All Enlarged to Show Degree of Hairyness on the Young Stem. (Courtesy of Dr. A. J. Pieters, office of Clover Investigations, U. S. Dept. Agric.)

Seed grown in Germany and in the Scandinavian countries is hardy, but according to Dr. A. J. Pieters, is susceptible to losses from the leaf-hopper, a tiny insect damaging to all smooth clovers. It is seldom that any excess of seed for exportation is produced in these countries.

Canadian red-clover seed gives excellent results in Northern and Corn Belt States and is highly desirable.

Under the provisions of the Gooding-Ketcham Act, imported red-clover seed is now required to be properly stained before entering the United States. The Italian red-clover seed, adjudged unadapted by the Secretary of Agriculture, must carry a red stain on 10 per cent or more of the seed. French seed and seed from other European countries must carry a green stain on 1 per cent or more of each lot of seed, and Canadian seed is stained purple to the extent of 1 per cent.

Since we are producing about half enough domestic red-clover seed to meet our annual demands, there is a strong market for native seed and an excellent and secure field for the red-clover seed grower. At the present time, far-seeing clover-seed growers and handlers are increasing desirable strains on new lands free of weeds in Colorado, Idaho, and in the Northern States and Canada.

The seed intended for a seed crop should be of highest purity. It is important that it be free of noxious weeds of all kinds, particularly dodder, buckhorn, catchfly, Canada thistle, and pigweed. Good clover seed is plump, clean, of a "bright" or "lively" color, and good odor. It should be tested for germination to secure certain knowledge of its viability.

Whenever it is possible to do so, the red-clover crop intended for seed should be planted on land that is free, or comparatively free, from noxious weeds or common weeds not ordinarily termed noxious, which may be harvested with the seed crop and prove difficult in separating from the clover seed.

Lime fields where necessary.—On soils in need of lime, it is essential that a sufficient application of ground limestone, agricultural or hydrated lime, or of marl or other form of lime be applied. Acidity in soils is indicated by failure of red clover to do well and by the flourishing growth of sorrel and frequently of dock. The most convenient method of testing the lime requirement of soils is by use of the Soiltex outfit developed by the Soils Department of the Michigan State College. The Truog tester of the Wisconsin Experiment Station and the Rich or Poor tester of the Illinois Experiment Station are very sat-

isfactory. The average acid soil needs 2 or 3 tons of ground limestone to put it in shape for growing a thrifty crop of clover.

Fertilizing with acid phosphate or a complete fertilizer high in phosphorus markedly increases seed yields in Corn Belt, Northern, and Eastern clover States. Phosphorus is essential in seed formation. The use of phosphatic fertilizers

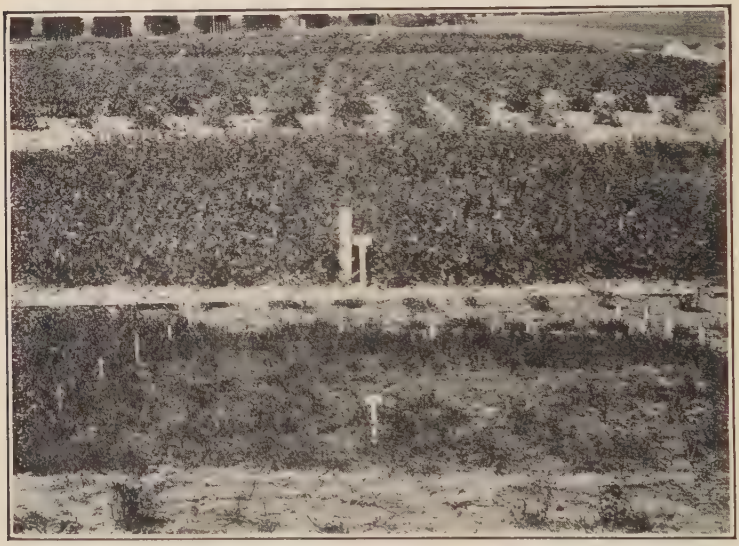

FIG. 85.—Second Growth (*above*) Several Weeks after First Crop of Red Clover was Removed (*below*). Hardy strains of red clover should be grown which produce a good first crop for hay and a thrifty second crop for seed, pasture and soil improvement. (Courtesy of Dr. A. J. Pieters, office of Clover Investigations, U. S. Dept. Agric.)

is followed by a heavier and earlier-maturing yield of clover seed. Applications of 200 to 300 pounds per acre of acid phosphate (16 per cent), or of a 4–12–4 or other complete fertilizer high in phosphorus, made when planting the grain crop with which clover is usually planted, markedly benefit both the companion grain crop and the clover.

Plant on a thoroughly compacted, clean seed bed.—Red clover is usually planted in the spring, using from 8 to 12 pounds of seed per acre (when planted without mixing with alsike or timothy). For seed purposes, it is highly advisable not to mix red clover with other legume or grass seeds. Plantings are usually made with a grain crop when planted in the spring. On wheat or rye, a grass seeder is employed as soon as the land is dry enough in the spring for the seeder to be operated. Many use a wheelbarrow seeder or a hand fan seeder, applying the seed in late winter or early spring while the ground is still honeycombed with frost, allowing the frost action to cover the seed. If broadcasted after frost action, the seed should be covered by use of the spike-tooth drag, harrow, or weeder. The seed drill, if used, or the harrow, should be drawn across the rows of wheat or rye at right angles.

If seedings are made with barley or oats, the seed should be planted through the grass-seeder attachment on the grain drill, allowing the seed to go ahead of, into, or behind the drills, and not through the drill holes with the oats or barley since it is then planted too deeply. Clover seed should be barely covered with earth—one-half or three-fourths of an inch deep at the most. The seed bed should be firmly compacted with a cultipacker either before or after drilling.

Best results in clover-seed production are often secured by planting on a clean, well-worked, firmly compacted seed bed without a companion crop, or with a light seeding (2 or 3 pecks) of barley or oats.

In planting red clover on new ground, inoculation with red-clover bacterial culture is advisable.

Cut the first crop for hay sufficiently early to control the clover-seed midge.—The clover-seed midge often makes seed production unprofitable in Corn Belt and Northern States clover regions. This pest is controlled by cutting the first crop of clover somewhat early—when the crop is in full bloom, but before any of the blooms have begun to turn dark in color due to ripening. Pasturing the first crop is also effective. Early

cutting permits the second or seed crop to make a rapid and early start and the seeds harden up at the time the adult midge is active, making entry into the interior of the seed difficult.

In northern regions, where the season is short, the first crop of red clover is most dependable as a seed crop.

Pull or rogue weeds from field, and mow weedy patches for hay.—From the time the seed crop is in full bloom to harvest

FIG. 86.—A Clean Field of Red Clover in Indiana, Showing Prospects of a Heavy Seed Yield. (Courtesy of J. C. Allen.)

time, excellent opportunity is offered for the pulling out of noxious weeds or other plants which make seed at the same time as the clover crop. Large patches, too weedy for rogueing, should be cut with mower or scythe, cured for hay, and removed before the seed crop is harvested. Lanes and fence rows and temporary roads in the field are often fringed with timothy, alsike, or weeds and the bordering crop should be mowed for hay.

Buckhorn is one of the worst weed pests of red clover and has made seed-growing unprofitable in many sections where it has secured a firm foothold in northern and Corn Belt States. Dodder is a bad pest of red clover and is carried in the seed crop in many Corn Belt regions, but is seldom found in the northern tier of states, due probably to winter conditions too severe for the dodder. Dock, pigweed, and night-flowering catchfly, white cockle, and Canada thistle can usually be successfully rogued by pulling, hoeing, or cutting.

By growing clover in a rotation following a cultivated crop such as corn, beans, beets, or potatoes, provided these crops are given thorough cultivation, a much cleaner seed crop can be secured. Clover seed is bought on a purity basis and the presence of weed seeds greatly reduces the price secured, particularly if the weed seeds are of noxious weeds whose seeds are removed with difficulty.

Harvest the second cutting for seed, if heads are sufficiently well filled.—The best seed crops are usually secured in seasons when comparatively dry weather follows a good growing season at the time when the blooms form and develop seed. During periods free of heavy rains, the best conditions are offered for pollination by bumble-bees and other insects. Inspection of the heads as they mature and turn brown will make it easily possible to estimate the probable seed yield. If from 15 to 20 well-developed seeds are found per head, a 2- or 3-bushel crop can be expected. If 30 to 50 seeds are found, a 4- or 6-bushel crop per acre usually results.

The seed crop is ready to harvest when the heads have turned brown. The crop is cut with a mower and thrown into windrows. After several days of curing, it is forked into small cocks and allowed to remain several days or a week or more. If not wet with rain, it may be threshed immediately. While the clover-seed crop can often be left in the field in small cocks for two weeks or more without injury, it is a mistake to leave it in the field too long, since the seed may be discolored by weather damage and the germination injured. It is an erroneous idea

that the seed crop should be allowed to "rot in the cock." The sooner it is threshed or hulled after it is in condition, the better.

The Birdsall clover huller is used almost universally in threshing clover. This machine slightly cracks or abrades the seed, making scarification of red-clover seed unnecessary.

Average seed yields by counties usually range from 1 to 2 bushels, but with proper care, yields of 4 to 6 bushels per acre

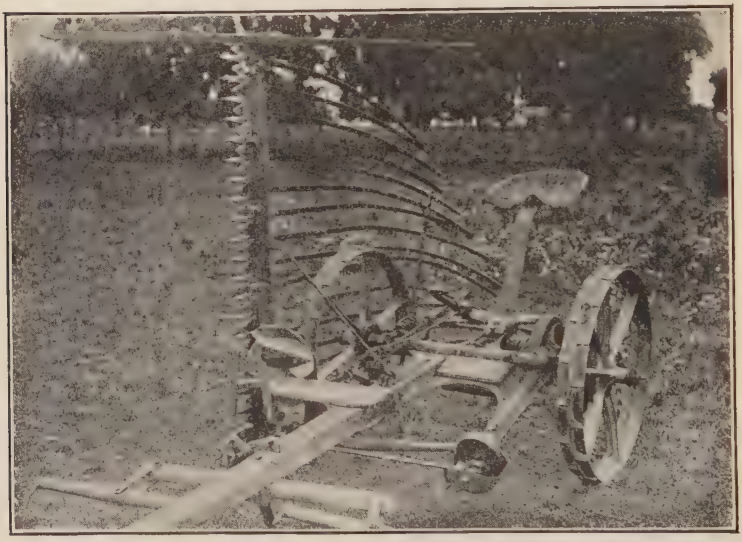

FIG. 87.—Mower with Swather Attachment Used in Harvesting Red Clover for Seed. (Courtesy of Dr. A. J. Pieters, U. S. Dept. Agric.)

can be reliably secured. At prices which have prevailed during the past few years, there is a handsome profit in growing red-clover seed. The seed crop should not be neglected, or considered a by-product, but will pay well if given proper attention.

Clean seed with a good fanning mill.—After threshing, the seed should be cleaned with the fanning mill to take out as much dirt, chaff, and weed seeds as possible. Such weed seeds as buckhorn, dodder, catchfly, and mixtures of alsike and alfalfa

will not be adequately removed by the fanning mill, and, if present, must be removed by the special apparatus of the commercial seed handler. Under average conditions, seed as it comes from the huller, after cleaning on the farm with the fanning mill, is not sufficiently free of weed seeds for planting. It will pay the grower, however, to remove as much dirt as possible. Clover seed in the dirt, or, as it comes from the grower, must usually have from 10 to 20 per cent of its weight removed at the cleaning plant in putting the seed in proper condition for planting.

FIG. 88.—Dodder, or Love Vine, is Frequently a Serious Pest of Red Clover in Corn Belt, Southern and Western Fields. It is seldom found in Northern States, being killed out by severe winters. Seed fields are greatly depreciated in value by the abundance of this weed. (C. A. Brigham, office of Visual Instruction, U. S. Dept. Agric.)

Ship in clean, strong bags, with tags inside and outside.—Clover seed, as produced on the farm, is either hauled to a nearby cleaning plant or is shipped to the co-operative cleaning plant or the plant of the seed dealer. Clean, strong bags should be used in shipping, and tags giving

destination and name of grower made in duplicate—one to be strongly affixed on the outside and one to be placed at the top, inside, before the bag is sewed. Outside tags may be easily pulled off.

MAMMOTH CLOVER

Mammoth clover, also called sapling or bull clover, is a large-growing variety of red clover. It varies from medium red clover in that it is from ten days to two weeks later in maturing, produces a coarser and larger growth, has solid stems while red-clover stems are hollow. The heads are borne singly and not frequently in pairs as with red clover. Mammoth clover plants are perennial and fields exist for three years instead of two as in the case of the medium red.

Mammoth clover is frequently preferred for green-manuring purposes and for planting with timothy since it matures at the same time as timothy.

Under present seed-marketing conditions, mammoth and red clover are sold interchangeably to a great degree. The seeds are identical in appearance and there is no sure way of identifying samples of unknown origin, except to grow a crop.

There is a great opportunity for the production of certified mammoth clover seed following a field inspection and certification system, accompanied by the sealing of bags which will assure the purchaser in regard to the authenticity of mammoth clover seed which he buys.

The first crop of mammoth clover is taken for seed. The same methods of harvesting and threshing are employed as with red clover. Owing to its viney growth, a pea-vine lifter attached to the mower bar will often aid greatly in effective harvest. Larger seed yields frequently result from mammoth clover. Average yields range from 2 to 5 bushels per acre but yields of 8 to 10 bushels are occasionally secured. Michigan, Wisconsin and Ontario, lead in mammoth seed production.

For seed production, seed known to be of a desirable strain

of mammoth should be secured. It should be planted at the rate of 10 or 12 pounds per acre, planting on clean ground and fertilizing with acid phosphate as recommended for red clover. It is usually planted with a nurse crop of small grain. Lighter plantings of 1 bushel or 6 pecks of small grain give better conditions for the mammoth clover than heavy grain plantings. The same precautions in keeping fields free of weeds as recommended for medium red clover should be employed.

GROWING ALSIKE CLOVER SEED

Alsike clover is particularly well-adapted to cool regions of ample rainfall. It will give best results on moisture-reten-

FIG. 89.—A Clean Field of Alsike Clover Grown for Seed in Presque Isle County, Michigan. Old fields of alsike seldom give high yields of clean seed. After the third or fourth year they become weedy unless carefully rogued. (From "Crop Production and Soil Management," John Wiley & Sons, Inc.)

tive soils and often yields large crops on soils which are too poorly drained for good results with red clover. Alsike is more winter hardy than red clover, not nearly as susceptible to diseases, will yield well on soils too acid for successful red-clover production. Apparently it will withstand greater extremes of

heat and cold, drought and over-abundance of water than red clover.

Alsike clover is grown for seed in Ontario, Michigan, Wisconsin, Indiana, and Idaho. Native production supplies the demand for seed. Its hay range includes the above-mentioned regions and extends into the Corn Belt and to some extent in Southern States. Alsike is commonly included in pasture and meadow seed-mixtures.

The alsike plant (*trifolum hybridum*) is finer-stemmed and more leafy than red clover. Its blooms are white or pinkish, its seed is small, greenish-colored and heart-shaped. Alsike is a perennial, fields producing profitably for periods of from three to five years. It will withstand pasturing to a greater degree than red clover.

Handling the seed crop.—The first cutting of alsike is usually taken for seed, since the season is not long enough in the northern localities where it is chiefly produced to permit the second crop to mature sufficiently.

Best results are secured if the crop is cut when the heads are brown and the seed is in the dough stage. Less shattering occurs at this time and a better color and finer grade of seed results. The crop is cut with a mower with windrowing or bunching attachment. If the vine growth is unusually heavy, a pea-vine lifter attached to the mower aids greatly in effective harvest. After curing on the field for a week or ten days, the crop is placed in the mow or stacked and covered until threshed. A clover huller is used in threshing. Yields of from 3 to 6 bushels of seed per acre can be expected from good fields.

Highest yields of seed are usually secured during the second and third season. As fields get older, they usually become more weedy and yields of seed generally decrease.

It will pay to rogue fields to remove night-flowering catchfly (sticky cockle), white campion, the docks, Canada thistle, and other weeds which go to seed with alsike. Patches of weeds should be cut with the scythe or mower before the seed crop and removed for hay. Timothy frequently comes into alsike

fields, particularly along fence rows and roads. Portions of the field carrying timothy should be cut early and harvested as hay or taken up separately if cut when the seed crop is harvested, and kept apart, being threshed after the main seed crop. The presence of timothy seed in alsike seed greatly reduces its value.

Night-flowering catchfly produces seed copiously. The catchfly seeds are very similar in size to alsike seeds, and being

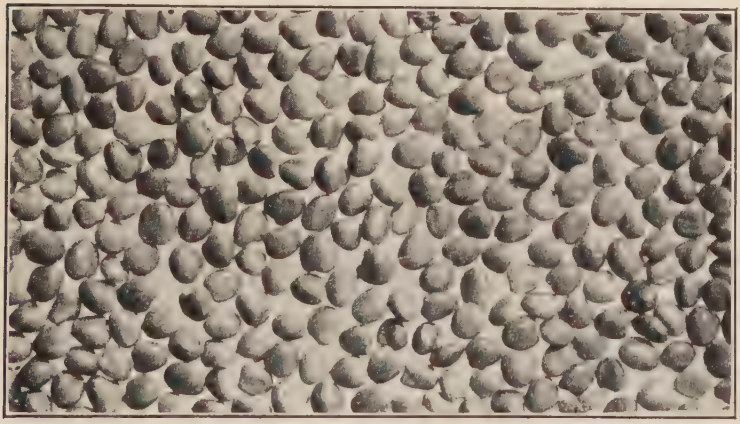

FIG. 90.—A Clean Sample of Alsike Seed. The seeds are small, heart-shaped, and of greenish color. (Photo by Prof. R. H. Pettit, Michigan Exp. Sta.)

of dark color, often pass undetected except by experts. This weed has become a great pest in Michigan and Ontario fields. It has been widely spread by the common practice of taking seed for neighborhood planting from the thresher spout or using uncleaned local supplies.

Only thoroughly cleaned alsike seed of high purity should be used by the seed grower. It should be planted on clean ground after a cultivated crop. Seed-beds should be thoroughly fitted and well-compacted. Alsike is usually planted at the rate of from 6 to 10 pounds per acre when seeded alone. Plant-

ings are made in early spring, usually with oats or barley, or the seed may be planted on wheat or rye. Seed production is stimulated by the addition of 200 to 300 pounds of acid phosphate or of a 4–12–4 or other complete fertilizer high in phosphorus.

Alsike meadows, unless unusually free of weeds and thrifty, should not be maintained after the third year.

WHITE CLOVER-SEED PRODUCTION

White, or Dutch clover, is used chiefly in pasture and lawn-grass mixtures. It is a shallow-rooted, low-growing perennial

FIG. 91.—Threshing a White Clover Seed Crop. Note the wheat in the unthreshed windrow. Cracked wheat is often a leading impurity in white clover seed. (Courtesy of Dr. A. J. Pieters, U. S. Dept. Agric.)

with creeping stems which root at intervals. While it thrives best in cool, moist regions on fertile soils, this clover occurs over practically the entire agricultural region of North America and Europe. Seed in small quantity is imported from Europe, but the domestic supply is largely produced in Ontario and in Michigan, Wisconsin, Oregon, Idaho and Louisiana.

The seed of white clover is of the same size and shape as alsike but differ in color, being yellow, reddish, or brown. Yields of from 2 to 8 bushels are secured. Canada thistle, buckhorn, catchfly, sorrel and dock are the chief weeds found in American white clover. Great difficulty is met with in securing white-clover seed free of alsike and timothy seed.

The Ladino is a giant variety from Italy. It is being grown commercially in Idaho and is coming into popular use in that state for pasture purposes under irrigated conditions.

Owing to the high price of white-clover seed, excellent opportunities are offered for the increase of seed production in clean fields in areas to which it is well adapted.

CRIMSON CLOVER

Crimson, scarlet, or incarnate clover is chiefly grown in New Jersey, Delaware, Maryland, and Virginia and states to the south. It winter kills in all but the southern part of the Corn Belt. As grown in the Eastern and Southern States it is fall-planted but occasionally is spring-planted in Corn Belt States. The plant is an annual.

Seed is planted at the rate of 15 to 20 pounds per acre, usually in late summer or early fall. It is harvested when heads are brown but before the crop is too ripe for great loss due to shattering. Handling when moist with dew prevents considerable loss of seed. The crop is cut with a mower with buncher attachment and cured for several days or a week in small cocks. It is threshed with a clover-huller. Yields of from 4 to 8 bushels of seed per acre are considered good.

The chief seed-impurities are buckhorn, Canada thistle, yellow dock, ox-eye daisy, and wild carrot.

The seed of crimson clover is larger and more globular than red-clover seed.

Seed crops are increased in yield by fertilizing with high-phosphate fertilizers using from 200 to 300 pounds of a 2–12–4 or a 4–12–6, or if ground is well supplied with organic matter

several hundred pounds of acid phosphate (16 per cent) per acre.

FIG. 92.—A Crimson Clover-seed Crop in Halifax County, North Carolina. (Office of Visual Instruction, U. S. Dept. Agric.)

GROWING SWEET CLOVER FOR SEED

The rapid increase in the use of sweet clover for pasture and hay and soil-improvement purposes has greatly increased the demand for seed. Since this crop is still new to many sections, and its acreage may be expected to make constant increase for a number of years, the production of sweet-clover seed will correspondingly increase. Sweet clover, however, yields seed so copiously and is so easily handled as a seed crop that there has been little difficulty in producing an annual seed supply sufficient for seeding demands.

The white biennial or common sweet clover is in greatest demand. This variety has the widest adaptation and gives

highest yields of forage or pasturage per acre. It offers a wider range of pasturage than the dwarf types.[1] Of these the Grundy County and the very similar Crystal Dwarf white-blossomed sweet clover have been widely exploited. They are smaller-growing and mature seed, with more uniformity, producing heavy yields of seed. Being finer-stemmed they are preferred by some who grow sweet clover chiefly for hay pur-

FIG. 93.—Sweet Clover should be Cut for Seed when Half or More of the Seed Pods are Brown. A binder or corn harvester is usually used for cutting and the sheaves are stood up in uncapped shocks for curing.

poses. Yields of hay, however, and of forage are only about three-quarter the yields produced under similar conditions by the common white biennial.

The yellow-blossomed biennial sweet clover is more decumbent in growth and finer-stemmed than the white-blossomed.

[1] A fine-stemmed, leafy, vigorous-growing white biennial sweet clover, three weeks later in blooming than the common, is in substantial increase at the Mich. Exp. Sta. It has great promise for mid- and late-summer pasturage when other pasture is short.

It does not yield quite as much and because of its reclining habit of growth is more likely to produce seed after the field is harvested, thus carrying over into following crops.

The Hubam, or annual white sweet clover, introduced by Professor Hughes of the Iowa Experiment Station, is finding a place as a soil-improvement crop, chiefly in the irrigated regions of Colorado and California. It is grown for hay and forage in Iowa and a few other Corn Belt States, but does not yield as well and is more susceptible to drought than the common white biennial.

The yellow-blossomed annual sweet clover is of importance only in California and a few Southern States.

HANDLING THE SEED CROP

Sweet clover is usually planted at the rate of 15 pounds per acre of cleaned and scarified seed. The seed bed should be firmly compacted and plantings made in early spring. Seedings may be made with barley or oats or on wheat or rye.

The first crop the following year is usually taken for seed in Northern States and the second crop in the Corn Belt. The seed is ready to harvest when from one-half to three-quarters of the seed pods are brown. Since the flowers ripen indeterminately, there is an unavoidable loss due to shattering of over-ripe seed and to the harvest of immature seed. The crop is usually cut with a grain binder, corn binder, or with a mower with buncher attachment.

Handling, when wet with dew, or after a slight shower, lessens loss through shattering.

The crop should be cocked as soon as cut while the stems are yet in a green and tough condition, so as to minimize loss of seed. Field seed-strippers are now in effective use.

The ordinary grain separator is used in threshing, removing every other concave, reducing the speed and using sweet-clover screens. Clover hullers can be used, but large-cylindered machines handle the coarse stems of sweet clover more effec-

tively. If a good job of hulling is not done by the separator, the seed must be put through a clover huller.

Yields of from 3 to 12 bushels of cleaned seed can be expected.

The chief weed pest of sweet clover is the common yellow mustard. A premium is now paid on seed produced in fields free of this weed, seed of which cannot be entirely removed from the sweet clover seed due to its similarity in size, round shape, and similar specific gravity.

Sweet clover fields should be carefully rogued of mustard, cockle, dock and Canada thistle.

The seed of sweet clover is very similar in size and shape to alfalfa seed. Since only one sweet clover seed is borne per pod its seed is more oval or roundish. Alfalfa seeds are flattened at the end where the next seed in the ram's-horn-shaped pod pressed against them. Sweet clover seed, particularly when crushed, give off the characteristic pleasantly sweet odor of cumarin.

CHAPTER VIII

PRODUCING ALFALFA SEED

Alfalfa has long been a major crop in the West, but during recent years the growing of alfalfa has undergone a tremendous increase in states east of the Mississippi Valley. The Corn Belt and Northern States, during the years 1920 to 1925, show an increased acreage of over 1,000,000 acres, almost doubling the production of this premier high-protein hay crop. Michigan, the leading state east of the Mississippi, increased her acreage from 74,000 acres in 1919 to 394,000 acres cut for hay in 1924, chiefly due to an organized movement on the part of the State Farm Bureau and leading seed companies, supported by the experimental and extension work of the Michigan State College in safeguarding the seed supply by directing purchase to regions of proper adaptation such as Utah, Idaho, Montana, the Dakotas, Ontario, and home-grown supplies.

With the development of increased supplies of Grimm, Ontario Variegated, and hardy common alfalfa seed from domestic sources, this great crop is on a much more dependable basis in Northern and Corn Belt States than it was in former years when large quantities of Argentinean alfalfa seed, poor and unadapted Turkestan seed, and seed from Arizona and the Southwest and other regions of mild climate was sold indiscriminately in these states, only to result in a high percentage of failures.

With large quantities of adapted seed available, alfalfa is now regarded as one of the most dependable forage crops to plant in the Northern and Central States where Grimm, hardy common, and Ontario Variegated are now generally planted by the informed growers in place of seed of unknown origin.

In the South, also, the use of common alfalfa seed from Kansas and Nebraska in the South Central States, and of the Hairy Peruvian, chiefly from Arizona, bordering the Gulf, is resulting in much greater satisfaction with alfalfa.

Alfalfa gives the highest yields per acre of the best hay and pasture for dairy cattle, beef cattle, hogs, sheep, and, if not overfed, for horses. Existing high freight rates prevent extentive shipping of hay and alfalfa meal from the West, which formerly supplied eastern markets, and a great eastward shift

FIG. 94.—Field Inspection of a Montana Grimm Alfalfa Seed Field. The Grimm alfalfa seed growers of northwestern Grimm-producing states grow seed for certification under regulations requiring field and threshed seed inspection. (Courtesy of A. J. Ogaard, Montana Agricultural College.)

of alfalfa-hay production in or near to the dairy and live-stock areas of the east has resulted.

The region east of the Mississippi produces comparatively little seed, with the exception of Ontario, and, hence, the annual seeding requirements of this region must be supplied largely from the northwest and Canada.

Granting that seed production in Michigan, Wisconsin, and Minnesota, and possibly the northern Corn Belt states will increase and may occasionally prove of considerable importance

in favorable years, the great bulk of the market alfalfa seed crop will very likely be produced in regions now supplying the market. It is not inconceivable that the acreage of alfalfa in the eastern half of the United States will be again more than doubled within the next ten years, offering a bright prospect for seed growers now supplying this territory.

By the application of the Gooding-Ketcham Act, alfalfa seed from the mild climatic regions of the Mediterranean countries and from South Africa must be stained red to the extent of 10 per cent on entry into this country. Argentinean alfalfa seed must be stained orange-red to the extent of 10 per cent before entering the United States. Former large annual importations of Argentinean seed, totaling in one year as high as 7,000,000 pounds, were distributed almost entirely in Corn Belt and Northern States where such seed is not adapted, and to a very slight degree in the Southwest and South. The Southwestern States are excess producers of seed. It will profit seed dealers as a class, as well as alfalfa growers, if the movement of alfalfa seed in the United States is based on the adaptation of the seed. The seed of Grimm, other hardy varieties, and hardy common of the Northwest, Ontario Variegated, and Grimm from Ontario, is naturally suited to the Northern and Corn Belt States. The common alfalfa seed of Kanas, Colorado, and Utah is generally well adapted in the Corn Belt and North Central States of the South. The excess seed of Arizona, Texas, New Mexico, and southern California should not be permitted to find its way to Corn Belt and Northern States market but should be used in the Southwest and in developing and increasing acreage of alfalfa in the Gulf States and other states of the South where tests and use proves the seed to be well adapted.

The production of alfalfa seed has developed to the greatest extent in regions of deficient rainfall, where irrigation is practiced. During dry summer seasons, paying seed crops are produced in increasingly numerous instances under eastern conditions.

In the Northwest and Central West the first crop is usually taken for hay and the second for seed. Water is applied to the first crop and usually withheld from the second. Yields of from 3 to 15 bushels per acre are usually secured.

Under eastern or humid region conditions, either the first or second crop is taken—the first crop, if rainfall is deficient at blooming time and seed develops well, and the second crop

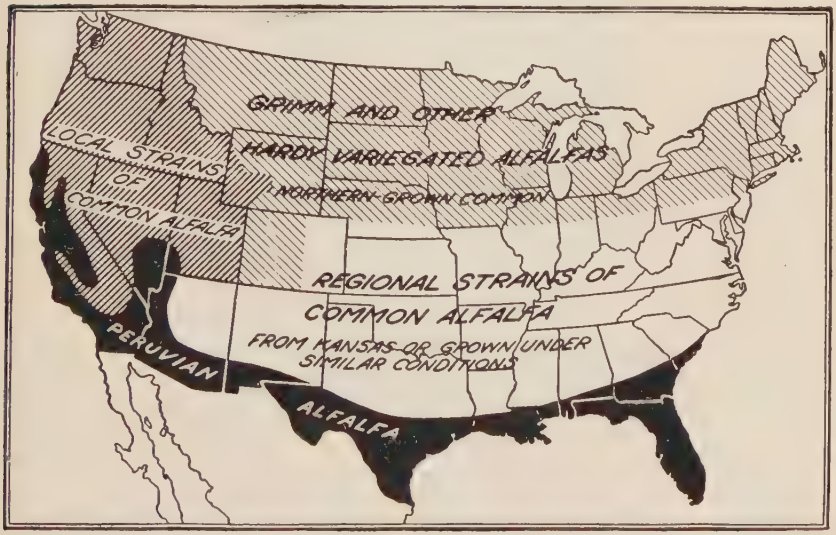

FIG. 95.—Outline Map of the United States, Showing the Varieties or Strains of Alfalfa that are Recommended for Various Sections, Based upon Climatic Conditions. (From F. B. 1467, U. S. Dept. Agric.)

if the first is removed for hay and the season favors seed development in the second crop. As a rule, dry weather just previous to and during the blossom and seed developing periods is associated with larger seed yields. Yields range from 2 to 8 bushels. In Ontario the first crop is allowed to mature seed.

The seed grower should choose the right variety for his market and for his soil and climatic conditions.—Common alfalfa is the most widely grown variety and, hence, will continue

to be produced by the greatest number of seed producers. The variety is characterized by flowers of blue and purple shades, and by high, comparatively narrow crowns and a large percentage of straight tap roots. Common alfalfa is extensively grown for seed in Utah, Colorado, Kansas, Nebraska, the Dakotas, and Montana. For hay purposes, common alfalfa is grown in these regions and is adapted for profitable alfalfa growing throughout the Corn Belt, the Southern States, and in the East Central and South Central States.

The Grimm alfalfa is an unusually hardy variety best adapted to the Northern States, northern part of the Corn Belt, and southern Canada, and also to regions of high altitude in more southern localities.

Grimm is a "variegated" variety characterized by blossoms of many shades, including yellow, white, blue, purple, and numerous blends of these colors. Its crowns are more branched than those of common, and the Grimm crowns are seated closer to the surface of the soil, frequently branching just below the surface. A much higher percentage of the roots of Grimm are branched. The low crown and branched roots and infusion of hardy strains represented by the yellow and smoky bloom characteristics, account for the hardihood of Grimm alfalfa and its resistance to heaving during the winter and spring.

The Grimm variety is of old Frankish origin (Westphalia, Germany) and was brought to this country by a German immigrant, Wendelynn Grimm, who planted it near Excelsior, Minnesota, in 1857. Mr. Grimm grew this alfalfa for a number of years and attracted the attention of his neighbors by his successful live-stock feeding operations during periods of drought and following severe winters,—conditions which rendered his neighbors unable to grow sufficient feed with other forage crops. The Grimm alfalfa spread slowly, locally, until it was carried to the Dakotas and other Northwestern States, where seed was more reliably produced, chiefly by the activity of Mr. A. B. Lyman of Excelsior, Minnesota. In recent years, well-organized Grimm Growers' Associations have developed in

FIG. 96.—Wendelin Grimm and His Wife.

FIG. 97.—Wendelin Grimm's Original Alfalfa Field as it Appeared in 1922, Sixty-five Years after Planting Near Excelsior, Minnesota. (Photo by courtesy of *The Seed World*, Chicago.)

Idaho, the Dakotas, Montana, and Utah for the extensive production of Grimm seed under a rigorous system of field inspection and seed certification. Grimm alfalfa seed sells at a premium over common.

Cossack alfalfa is a hardy variety introduced into the United States from Siberia by Professor N. E. Hanson of the South Dakota Experiment Station. It is a variegated variety showing much the same blossom colors as Grimm, with a higher percentage of yellow and white blossoms. It is well adapted to regions of rigorous climate.

The Hardigan (Hardy Michigan) variety is a selection of the Baltic, made by Professor F. A. Spragg of the Michigan Experiment Station from a number of selections submitted from Mr. P. K. Blinn of the Rocky Ford Experiment Station, Colorado, who secured the original heavy seed-producing Baltic stock from Mr. W. A. Wheeler of the United States Department of Agriculture, then located in South Dakota. This variety blossoms profusely, carrying the yellow and yellow-blend blossoms which mark the hardy variegated varieties. It produces seed copiously and leads all other known varieties in developing seed under the humid conditions of Michigan and other eastern regions.

In the West the Hardigan is exceeding unselected or common Grimm varieties in seed production. At the Aberdeen, Idaho, sub-station, the Hardigan is reported to have produced more than double the amount of seed secured from like areas of Grimm during annual tests covering the years of 1924, 1925, and 1926.

This variety leads in forage tests at the Michigan Experiment Station and the production of seed in Michigan is gradually increasing as methods of seed-growing are becoming more generally understood. Since the Hardigan is a development of the Baltic, which is apparently of origin similar to Grimm, the Hardigan may be considered, for all practical purposes, as a selected strain of Grimm. It is similar to Grimm in all of its characteristics, but is more uniform in growth and yields seed more copiously.

Orrenburg alfalfa is a very hardy yellow-flowered alfalfa with a decumbent habit of growth. It produces comparatively small yields of hay but is advocated as a pasture variety in certain Northwestern States because of its tendency to produce branched roots with additional crown development, thus resisting damage by grazing. Its production is chiefly limited by the difficulty met with in harvesting seed on a profitable scale. The seed of Orrenburg is borne in sickle-shaped pods, each of which carries a single seed. This seed ripens unevenly and shatters easily, hence, seed harvest is difficult and yields are small.

The Ontario Variegated alfalfa has been produced in increasing quantities during the past five years and is meeting with favor in Michigan, New York, Ohio, and other Northern and Corn Belt States. It is apparently a true variegated alfalfa since the characteristic colors of yellow and yellowish blends are found, though sparingly, among its blossoms. There occurs, however, a great profusion of white and light purple blossoms among the preponderating purple blooms, giving fields a dappled appearance at blossom time. The Ontario Variegated, in tests made at the Ontario Station and at the Michigan Experiment Station, is apparently more hardy than the common alfalfa but not quite as hardy or as enduring as the Grimm.

The Ontario Variegated sells at a price about midway between common and Grimm and the demand is increasing rapidly.

The Ladak variety is a very hardy variety introduced from northern India by Mr. H. L. Westover, Alfalfa Specialist of the United States Department of Agriculture. At the Redfield Sub-station of the United States Department of Agriculture, this variety is giving excellent results in seed and forage production and has been proven to be of unusual hardihood.

The Hairy Peruvian gives great yields of forage and seed in southwest and Gulf-border. It is characrerized by broad leaves and hairy stems, the blossoms being purple in color. It is not sufficiently hardy for Corn Belt and northern localities,

but is apparently best adapted in southwestern regions and in a narrow region bordering the Gulf of Mexico.

Turkestan alfalfa, formerly imported to the United States in considerable quantity, is quite variable. Some lots of Turkestan have shown hardihood, but for the most part Turkestan alfalfa has shown a marked tendency to winter killing and meets with little demand.

FIG. 98.—An Alfalfa Seed Field Near Deseret, Utah, which is Over Fifty Years Old. In the memory of the gentleman shown in the photograph, seed has been harvested annually for over forty years from this field. Millard County is the leading alfalfa seed-producing county in the United States. Owing to the high altitude, approximating 4500 feet or more, fairly severe winter conditions prevail, temperatures of less than zero being not infrequent.

Alfalfa varieties may be briefly classified as follows:

Medicago sativa, characterized by blue and purple blossoms, upright stems, high crowns, and a preponderance of straight tap roots. Seed pods are shaped like a ram's horn. Common alfalfa is a typical example.

Medicago falcata; this group has yellow flowers, a decumbent habit of growth, low-set branched crowns, and a preponderance of branched roots. Its seed pods are sickle-shaped. Varieties of this species, such as Orrenburg, are extremely hardy.

Variegated alfalfas are hybrids of *Medicago falcata* and *Medicago sativa.* The blossom colors are light to dark shades of blue and purple, with admixtures of white and yellow and blends of yellow or " smoky "-colored blooms. The

variegated alfalfas are hardier than the common. Grimm and Cossack are typical variegated varieties.

For the alfalfa seed crop, choose clean, well-drained soils, well supplied with lime and the mineral elements of fertility. While alfalfa is adapted to a wide range of conditions, it pro-

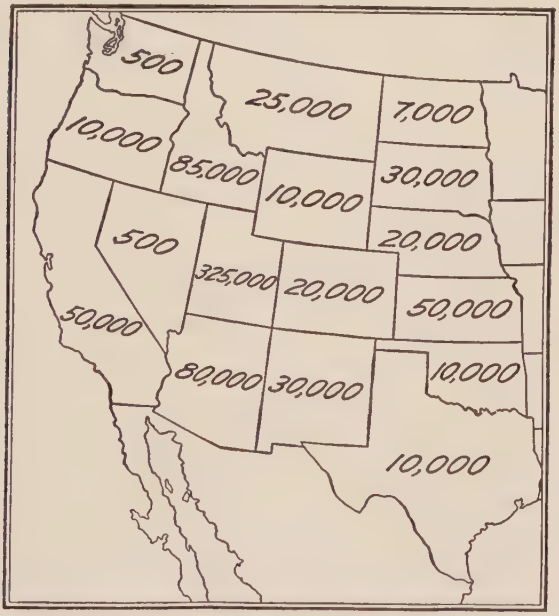

FIG. 99.—Map Showing the Estimated Production (in bushels) of Alfalfa Seed in 1924 in the States Lying West of the Ninety-fifth Meridian, Based on Information Obtained by the Seed-reporting Service of the Bureau of Agricultural Economics, United States Department of Agriculture. (From Farmers' Bul. 1467, U. S. Dept. Agric.)

duces seed best on well-drained soils which are high in calcium and magnesium carbonates (lime) and in phosphorus and potash. In Utah and Idaho, the irrigated desert soils, particularly those naturally alkaline in reaction, rank among the highest seed yielders. Apparently a degree of alkalinity, just sufficient to

threaten the growth of the plant and retard production of most other crops, causes an increased production of seed. Yields of 16 to 18 bushels per acre have been secured in Millard County, Utah, under such conditions. Too alkaline a condition prevents seed production. Old-established fields of Millard County (the leading alfalfa seed county of the United States), which become too alkaline for successful forage or seed production through long years of irrigation, have been reclaimed for alfalfa and other crops by tile drainage. In the Rocky Ford district of Colorado, former high-producing seed areas have ceased to produce paying quantities of alfalfa seed due to the development of nitrates in the soil under irrigated conditions. The excessive content of nitrates stimulates vegetative production and retards seed production.

Under humid-area conditions, the best seed yields are secured on comparatively heavy soils in Ontario and in eastern Michigan. These soils are fertile and calcareous.

Sandy loams of Michigan occasionally give good seed yields under favorable seasonal conditions.

Under irrigated conditions, fields should be selected which are free of dodder, sweet clover and other plants, the seeds of which cannot be easily separated from alfalfa seed.

Under humid area conditions, the seed crop should be planted on land which is free of catchfly, buckhorn, quack grass, mustard, red clover, alsike, and other weeds or plants which might cause a mixed-seed condition at harvest which would detract from the value of the seed crop.

Commercial fertilizers are little used in the Northwest seed-producing areas and are apparently, as yet, unnecessary. In regions east of the Mississippi, acid soils must be limed to correct acidity. Usually 2 tons of finely ground limestone or $1\frac{1}{2}$ tons of hydrated lime are needed per acre. Soils should be tested for acidity by using the Soiltex outfit, the Truog, Rich-or-Poor, or Litmus test and lime applied in the needed quantities.

Acid phosphate and complete fertilizers high in phosphorus give excellent results in stimulating alfalfa-seed production on

soils of the Northern States. Using acid phosphate at the rate of 300 pounds per acre gave an increase of over 300 per cent in alfalfa-seed production on the sandy loam soil of the Mancelona Sub-station in the northwestern part of lower Michigan, according to Dr. M. M. McCool. Improved yields from the use of phosphorus are to be expected on most soils of the humid area where alfalfa seed is attempted.

Plant alfalfa for seed on a clean, well-surfaced and firmly compacted seed bed. Plowing should be done in fall or early spring to permit the seed bed to settle thoroughly and fitting should be accomplished with disc and spring tooth or spike-tooth harrow, followed by the cultipacker or a weighted roller to firmly compact the surface. Seedings made on winter wheat or rye are, of course, made on well-settled ground, but the use of the cultipacker after seeding is advisable.

Under western conditions where irrigation is practiced, the seed bed must be leveled by use of heavy drags and the fresno scraper.

Generally from 4 to 8 pounds of seed per acre is sufficient. Comparatively light plantings give heavier seed yields than fields planted to the amounts usually seeded for forage purposes.

The practice of planting 2 or 4 pounds of seed per acre, in rows 28 inches apart, formerly employed in Idaho and Montana, is being discontinued and broadcast seedings at the rate of 4 to 8 pounds per acre are being more commonly made.

Seed of a new variety, which is scarce and high in price, may be more rapidly increased by planting at the rate of 1 pound per acre in rows 28 inches apart, using a garden drill or stopping all but every fourth hole in a grain drill in planting. Keeping weeds down in row plantings adds greatly to the cost of seed production.

Inoculation of the seed or soil with the proper bacterial culture for alfalfa is advisable when seeding land where alfalfa has not been grown previously.

Allow crop to go to seed when bloom sets seed to a sufficient degree. In Millard County and in the Uinta Basin, Utah, experi-

enced seed growers considered rainless weather, with the sun's rays diffused through a condition of slight cloudiness, as favoring seed setting. Though no definite experiments prove the fact, many growers consider the presence of numerous yellow butterflies (the cabbage-worm butterfly) flying over fields in blossom as a sign of conditions favoring seed setting.

FIG. 100.—A Well-burred Alfalfa Plant almost in Condition for Seed Harvest. When three-fourths or more of the seed pods are brown the crop is ready to cut. (Photo by Prof. R. H. Pettit, Michigan Exp. Sta.)

Pollination is aided by bumble bees and alkali bees (not true bees, but a leaf-cutting insect—"*Megachile*"). Heavy insects, by tripping the blooms, accomplish self-pollination and a certain degree of cross-pollination due to pollen carried from other flowers. Alfalfa blooms are, for the most part, self-pollinated. Comparatively dry and warm weather at blossom time causes the blooms to trip to a greater degree, accomplishing fertilization. Intermingling cloudy and sunshiny periods with light showers and moderate wind is considered good seed setting weather. Tripping consists in the quick release of the anther, which causes pollen to be dusted on the stigma below. (When alfalfa blossoms are in full bloom, it is interesting to note the process of tripping which takes place when a stick-pin or fine stem of grass is pushed into the bloom cavity.)

Western seed growers like to see seed development take

place without too great a show of bloom, the blossoms quickly "burring" or passing into the seed-setting stage. As one successful seed grower expressed it, he likes to see the "bloom slip into the burr" rapidly.

The "stripping," "slipping" or "falling off" of the bloom results in a light yield of seed. Blooms slip or fall off due to the application of too much water or to too much rainfall, and the action of tiny insects known as thrips. Frequently stripping occurs for no known reason. Fields which strip badly are harvested for hay.

The probability of a paying seed crop can be determined during the period of late bloom, when seed is setting, by pressing the base of a number of blossoms between the fingers. If from 50 to 60 out of 100 blooms have an appreciable swelling, a seed crop of three bushels or more per acre can be expected. If 60 per cent or more blossoms show developing seed, seed yields of 6 bushels or more may result.

The eastern alfalfa seed grower must learn how to judge the possibilities of a seed crop in the same manner as the western grower. When blossoms fall to the ground or fail to set, and feeling of the blooms indicates a small amount of seed development, the crop should be taken for hay. If, however, either the first or second crop shows a tightly held bloom and a satisfactory percentage of developing seed, the crop may be allowed to remain for seed production with expectation of a paying crop.

Harvest when seed is sufficiently mature.—Generally the browning up of three-fourths of the seed pods is considered a good indication of the right time to begin harvest. A self-rake reaper is usually employed, or a mower with a buncher attachment. The seed crop is allowed to cure in windrows or small cocks for a week or ten days. It is then stacked in large stacks for threshing or may be threshed from the field if a thresher is immediately available.

The stack should be built on a large tarpaulin held off the ground a foot or so by a layer of old hay or straw. The top of stack should be protected by canvas or a layer of hay or straw

held down by poles or ropes weighted at the ends and thrown over the stack. The use of canvas on the bottoms of wagons used in hauling in the seed crop for stacking or threshing and spread on the ground at the threshing spout will prevent the loss of much seed.

Threshing is done with a separator equipped with alfalfa-seed screens or with a clover huller with proper screens. As the seed comes from the thresher, or "in the dirt," it carries

FIG. 101.—Grain Separators Equipped with Alfalfa-seed Screens and Run at a Reduced Rate of Speed are Usually Used in Threshing in the Millard County and Uintah Basin Seed Areas of Utah. In other regions, clover hullers with alfalfa-seed screens are generally employed. (Millard Co., Utah.)

from 10 per cent to 30 per cent of chaff, weed seed, and immature or shriveled seed.

The chalcis fly affects alfalfa by causing a great percentage of hollow and misshapen seeds, and a light seed yield.

In the West and Northwest, the most common weeds found in alfalfa seed are giant or large-seeded dodder, Russian thistle, yellow trefoil, salt brush, fox tail, morning glory, and amaranth. Sweet clover frequently grows along ditch banks and may

spread into the fields. While not a weed pest, it cannot be removed from the seed and care should be taken to keep ditch banks mowed.

Clean seed with fanning mill and special cleaning machinery.—After alfalfa seed is threshed, it must be cleaned for the market by use of the fanning mill and such special apparatus as the gravity machine and the Eddy mill. The fanning mill will

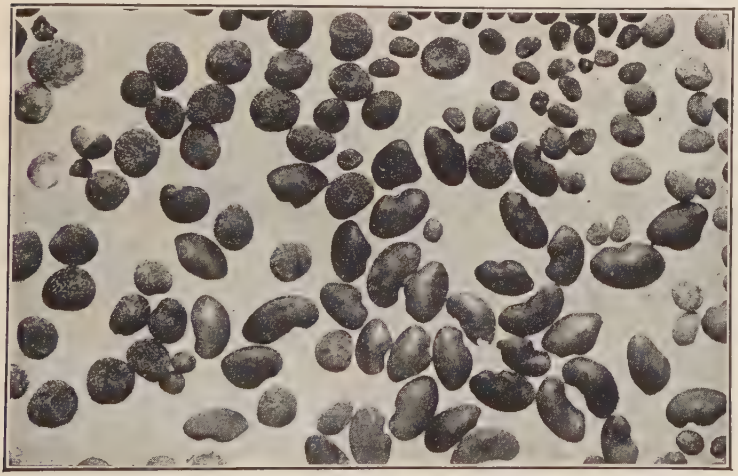

FIG. 102.—Giant Dodder is a Frequent Pest in Utah and Northwestern Alfalfa-seed Fields. Infested areas should be cut separately and used for feed, or threshed separately after the main crop. This weed seed must be cleaned from the alfalfa seed by an expensive cleaning process. (Office of Visual Instruction, U. S. Dept. Agric.)

take out nearly all of the dirt, chaff, thin seeds, and a large percentage of weed seeds. The gravity mill is then used for removing Russian thistle seed, salt brush, and many other weed seeds.

The Eddy mill is effective in cleaning lots of seed not easily cleaned by the fanning mill and gravity separator.

After cleaning, large amounts of alfalfa seed are scarified by using the scarifier which abrades and cracks the seed coats,

increasing the percentage of germination. This process increases the cost of marketing seed by 25 to 50 cents per bushel. Recent work of the Montana Experiment Station is reported to show no difference in the stand secured from scarified and unscarified seed.

Since scarified seed cannot be kept as long as unscarified seed without serious loss of vitality, it appears likely that the practice of scarification will decline except in the case of seed lots carrying an unusual amount of hard seeds.

The cleaning of alfalfa seed after threshing, is performed

FIG. 103.—Hauling Field Run Alfalfa Seed to the Cleaning Plant. (Utah.)

at central cleaning plants either privately or cooperatively owned. These plants are usually located in the production areas and seed growers receive a price based on the percentage of clean seed in their crop.

Alfalfa seed from northern states and Canada is often dull in color due to weather damage or carries a comparatively high per cent of immature seed as a result of early frost. Seed from the Southwest is nearly always plump, large, and of bright color. The alfalfa grower of northern regions must not buy seed on appearance only but must depend on germination tests, and

when necessary, due to bad seasons in the Northwest and northern producing areas, make some allowance for its appearance. Adaptation, purity, and germination are the important considerations.

Alfalfa-seed growers' associations have been formed in many western states. In Idaho, the Idaho Grimm-Growers' Association maintains a strict field inspection under state supervision. Seed is cleaned for marketing at a cooperatively owned and

FIG. 104.—A Country Seed-cleaning Plant at Duchesne, Utah, One of a Number Operated by a Large Seed Company. The establishment of cleaning plants in production areas is advantageous in reducing freight costs by retaining the dirt cleaned from the seed amounting to 10 to 30 per cent of the seed weight at the cleaning point. (Courtesy of J. G. Peppard Co.)

managed plant at Blackfoot, Idaho, and marketed under the Blackfoot Brand.

In South Dakota, the South Dakota Grimm Growers produce field-inspected and certified seed, marketing for the most part through their plant at Rapid City.

Certified Grimm Growers' Associations of Idaho, Utah, and Montana have agreed on a uniform plan of inspection and certification under supervision of their State Departments of Agriculture and aided by their Agricultural Colleges.

In Utah, the "Beehive Growers," producers of common

alfalfa seed, have organized for effective production and market their Beehive Brand seed through the agency of a seed firm with whom they work in agreement.

In Michigan, Hardigan alfalfa seed is grown under the inspection system of the Michigan Crop Improvement Association and cleaned and marketed through the Seed Department of the Michigan Farm Bureau, or directly by growers.

Many leading seed companies handle certified Grimm seed from Grimm Growers' Associations and as certified and sealed by State certifying agencies.

Leading insect pests which cause much loss to alfalfa-seed growers.—The chalcis fly lays its eggs in the developing seed pods. Tiny larvae develop within the seed, just before maturity, and bore their way out of the seed coats, leaving a hollow shell. Losses from the chalcis fly occur in nearly all seed-producing areas.

In reducing losses from this insect, it is important that alfalfa, clover, and sweet clover in field corners and along ditch banks be prevented from making an early seed crop, which serves as a source of infestation for the later field seed crop. Early harvested seed crops should be stacked immediately to prevent the adult chalcis fly from emerging and laying eggs on seed crops still in the field. Infested screenings should be burned as soon as they accumulate during threshing. Fields so badly infested as to be worthless for seed should be cut for hay and stacked.

Grasshoppers often cause much damage throughout the seed-growing areas both West and East. They eat the developing seed pods as well as the blooms and leaves. While heavy infestations are reduced by the development of parasites, such reduction does not occur until much damage is done. Where this pest appears, organized community effort directed along the lines of poisoning and the plowing or discing of waste ground carrying the egg masses is effective.

The most effective and most commonly used poison bait is the mixture made as follows:

100 pounds bran
5 pounds white arsenic
3 ounces sodium arsenate
2 gallons molasses
4 ounces amylacetate (banana oil)
1 pound salt

Mix thoroughly with 12 to 15 gallons of water. Grasshoppers tend to work toward the borders of the fields for the night,

FIG. 105.—In the Irrigated Districts of Utah and Idaho Water is Applied to the First Crop, but Usually Withheld from the Second Crop of Alfalfa which is taken for Seed. (Millard County, Utah.)

hence, this bait is most effectively used when spread, broadcast, (thinly, so birds and animals will not be poisoned), around the borders of the fields just at dawn, before the hoppers have penetrated toward the center.

The alfalfa weevil now occurs in Utah, Idaho, Oregon, Colorado, and Wyoming and is constantly spreading. The adult weevil winters over under alfalfa crowns or stubble and in weeds along ditches and fences. The adult begins work on the early shoots in the spring, piercing the stems and laying its eggs. The larvae develop and are active just before the first cutting

is usually taken for hay. They are small, green worms with a yellow stripe and white and dark dots and are nearly one-half inch long. These worms work chiefly where new growth occurs, eating away the terminal buds. When the hay crop is removed, the larvae remain on the ground and work on the new growth, sometimes keeping fields bare for several weeks.

In controlling this insect, large harrows are made by stringing barbed-wire on a strong frame. These harrows, when dragged over fields after cutting, leave the surface in a fine dust mulch and the larvae, being unable to find shade, die in the hot surface soil.

Spraying with lead or calcium arsenate is also resorted to. The most commonly used spray is made by using 2 pounds of lead arsenate in 100 gallons of water in which four bars of laundry soap have been dissolved. The spray is applied with a power sprayer, using 80 to 100 gallons per acre and applying as soon as damage from weevils is noticed in the growing crop. The spray can be applied more cheaply and is more effective than the harrow method.

CHAPTER IX

KENTUCKY BLUEGRASS-SEED PRODUCTION AND MARKETING

By Prof. E. J. Kinney, Professor of Farm Crops,
University of Kentucky

Kentucky bluegrass (*Poa pratensis*) is most certainly of European origin and is not, as has been frequently claimed and as its name would indicate, native to Kentucky. The French, who made several settlements in the Ohio Valley about 1700, probably brought bluegrass with them, which accounts for the fact that it was apparently rather plentiful in various places when the settlement of this area began toward the latter part of the eighteenth century. It was first utilized extensively for pasture in Kentucky, hence the name Kentucky Bluegrass. The prefix " Kentucky " is seldom used except by seedsmen as the term " bluegrass " when used alone is generally understood to refer to Kentucky bluegrass. Kentucky bluegrass is often called June grass in the more northern sections.

Bluegrass is a moisture-loving plant and is therefore found only in the humid regions of America and in the limited areas where irrigation is practiced. Roughly speaking, what may be termed the bluegrass region proper of America, extends west to the Missouri river and slightly south of the southern boundary of Tennessee and North Carolina. Southern Canada is of course included in this area. In the most southern parts of the country, bluegrass cannot withstand the long summers unless given special care. In the northern range the grass occurs on almost all types of soil of fair productivity. Further south it thrives only on the most fertile soils, chiefly those of limestone origin.

Such are the soils of the famous bluegrass regions of Kentucky and Tennessee where bluegrass probably grows to greater perfection and is more extensively utilized on the best and most level lands than anywhere else in the country.

Throughout the areas of its adaptation, Kentucky bluegrass is the predominant type of vegetation along roadsides, fence rows, open woodlands or wherever land is left undisturbed for some length of time. As some one in a poetic mood has

Fig. 106.—Cattle on Blue-grass Pasture. A typical scene near Lexington, Kentucky, in the leading blue grass seed-producing area of the United States after the blue grass seed crop has been stripped. (Courtesy of Farm Economics Dept., University of Kentucky.)

remarked, "It is the magic green carpet which covers up the naked earth." It is the fence and roadside bluegrass that furnishes the seed which is everywhere present in the soils of bluegrass regions and permits it to become established even when no seed is sown.

Bluegrass is decidedly the most important pasture grass of North America. Rough hill lands, woodlands and other land not adapted to cultivation furnish a large part of the pasturage of this country and no matter what pasture crops are sown

originally, it is only a question of time until bluegrass drives them out to reign supreme thereafter.

It is fortunate that with its aggressive character Kentucky bluegrass combines a number of admirable qualities which make it a really great pasture grass. It is permanent, actually improving with age if properly managed. It makes a smooth, even, tough, elastic turf, withstands tramping without injury and effectively prevents erosion. It is nutritious and preferred by all kinds of live stock to all other grasses adapted to this country. It starts growth as early as any grass and continues growing in the fall until freezing weather. The dry herbage is nutritious and palatable. The only disadvantage of bluegrass is its rather low yield of forage. On lands suitable for cultivation, other more productive pasture crops can be grown and bluegrass is utilized on such lands extensively in only a few areas where it is particularly productive.

Bluegrass is the standard lawn grass of the country. Even in regions poorly adapted to it, good lawns are maintained by giving them special care. It is used everywhere for public parks and is the approved grass for the fairways of golf courses. A good part of the commercial seed crop is utilized for seeding lawns, golf courses, etc., but an increasing amount is being used in many parts of the country for seeding pastures, especially by men engaged in pure-bred stock raising. By sowing seed, usually a good pasture may be obtained in a fraction of the time required otherwise. It is real economy to sow seed whenever a permanent pasture is to be established. Bluegrass is a poor hay grass and is seldom used for this purpose.

BLUEGRASS-SEED PRODUCING AREAS

There are but two important seed-producing areas. One in North Central Kentucky, comprising a few counties in the bluegrass region of that state, and the so-called Missouri area which in reality is partly in Iowa and even extends into northeastern Kansas and southeastern Nebraska. In addition to

these areas small quantities of seed have lately been stripped in favorable seasons in southwestern Ohio, probably mostly in Fayette and Clinton counties and in central Indiana and central Illinois.

In the Kentucky area a large percentage of the seed is produced in the neighborhood of Lexington, Paris and Winchester, in which cities practically all the seed is cleaned and marketed. The leading producing counties are Fayette, Bourbon, Clark, Woodford, Jessamine, Montgomery, and Scott, but stripping is not confined entirely to these counties. This is a section of gently rolling land of remarkable beauty and with soils of great natural fertility. It has long been famous for the production of thoroughbred horses and pure-bred cattle and sheep. In addition, many beef cattle are prepared for market. Stock is maintained largely on pasture throughout the entire year which necessitates that a considerable percentage of the land be kept in grass. Much of the land is held in large tracts and it is on the larger farms that most of the bluegrass seed is produced.

In the Missouri area the country is less rolling than in Kentucky and a larger percentage of the land is devoted to cultivated crops and small grains. It is primarily a beef cattle section, however, with large farms and with pasture an important factor in preparing the cattle for market. It is only under such conditions that the production of bluegrass seed is practical.

HANDLING BLUEGRASS PASTURES FOR SEED PRODUCTION

Bluegrass seed is obtained as a by-product from pastures and the production of seed is therefore a secondary consideration, in most cases. It is a fact, however, that some farmers find seed production the largest source of profit so that the pastures are managed primarily from the standpoint of seed production. As stated previously it is only on the larger farms where much bluegrass is stripped. On these farms the acreage of grass is large and during the spring, growth is usually luxuriant. All the pasture is not needed at this time and the better and

cleaner fields are not pastured, or at least only lightly, until after the seed is stripped. If necessary cattle may be given some feed in order that the seed pastures may remain undisturbed. Where it is necessary to pasture all the grass in the spring the chances of getting a seed crop become uncertain. On fields pastured only moderately heavy, the production of seed heads may be quite heavy in favorable years and half the normal yield may be obtained. In case the spring is dry, pastured

Fig. 107.—The Old-style Comb Stripper. (Photo by Farm Economics Dept., University of Kentucky.)

fields are rarely worth stripping. In the Missouri area less effort is made to keep stock off the fields than in Kentucky. After stripping the seed, fields are pastured heavily until the latter part of July, then lightly until the middle of September, and heavily until well up in December. Probably the character of the weather during the fall determines quite largely the yield of seed the following year. If the rainfall is sufficient to permit grass to make a vigorous fall growth, the plants store up a supply

of nutritive material in the root stalks which contributes to a rapid and vigorous spring growth the following year.

Bluegrass pastures can seldom be stripped before the third year after seeding. After the tenth year, weeds commonly become abundant. In recent years sorrel or sour dock has become especially troublesome in old fields. The usual custom in Kentucky is to keep fields in bluegrass six to ten years. They are then plowed up and two crops of tobacco grown on the best part and corn on the poorer parts. Bluegrass, together with a few pounds of timothy, is sown in the fall with a small grain. In the spring a light seeding of clover is made. Usually the field is used for hay for one year and then pastured. By about the third or fourth year the timothy and clover have practically disappeared, or so little is left that it does not interfere with stripping.

STRIPPING AND CURING

Bluegrass seed cannot be threshed like timothy and redtop because the hairs or filaments of the chaff hold the seeds and chaff together so firmly. Instead, the heads are stripped from the standing grass, thoroughly dried, and cleaned for market by elaborate and costly machinery.

The first strippers used, and still used to some extent, consist of a platform or box mounted between two high wheels and armed in front with a heavy steel comb. The heads are caught in the steel comb and a laborer riding in the box keeps the comb from clogging by moving a sharp instrument back and forth over it, at the same time pushing the seed to the rear part of the box. This stripper is pulled by one horse or mule. In recent years a very efficient stripper has been developed which requires but one man to operate it, and it is fast superseding the old stripper. The important features of the modern stripper is a toothed reel which takes the seeds from the comb and automatically deposits them in a bag or box. All strippers used in Kentucky are manufactured by a local concern.

In the Missouri district, rotary strippers are used exclusively.

These consist of a toothed cylinder which revolves rapidly, thus pulling the seeds from the heads and throwing them into a box behind. They do not gather the seed as clean as the comb strippers but do not pull up the grass as sometimes occurs when comb strippers are used on soft ground. The seed gathered by rotary strippers also contains less straw and other trash.

Stripping begins in Kentucky in early June or whenever the seed heads begin to yellow slightly, and continues for from one to two weeks. When the seed becomes over-ripe the seed stalks

FIG. 108.—Automatic Strippers at Work in the Blue-grass Region of Kentucky. (Courtesy of McCormick Co., Lexington.)

are likely to break over in the event a heavy rain and wind storm occurs and the seed may shatter badly, hence stripping is rushed to completion as rapidly as possible. The hurry to get the crop harvested and the desire to get as much service out of each machine as possible results sometimes in stripping the seed while too green. This gives a small yield of cleaned seed of low viability.

Many—perhaps most—of the large growers own their strippers, but a large amount of seed is stripped by contractors, usually on the basis of half the seed. In the Missouri district

stripping begins about two weeks later than in Kentucky and continues over a somewhat longer period.

The yield of seed varies from 5 to 30 bushels per acre, the larger figure being reached only in exceptional seasons on fields that have not been pastured. Perhaps the average yield in Kentucky over a period of years is about 8 bushels per acre.

As fast as the seed is stripped it is packed in bags holding

Fig. 109.—Blue-grass Seed Curing in the Open. (Photo, Dept. of Entomology and Botany, University of Kentucky.)

about 100 pounds of green seed and taken to the curing place. In past years practically all seed was cured out of doors on closely clipped grass areas. In recent years dealers who buy green seed have been utilizing the large loose-leaf tobacco auction warehouses found in central Kentucky towns for curing immense amounts of seed. Curing indoors is largely a matter of convenience as no better seed is produced. In fact, unless carefully managed, the seed is more likely to be injured by

heating when cured indoors than when cured outside. The seed is piled in parallel windrows 2 or 3 feet high and equally wide. The green seed heats readily, and for a few days the windrows must be turned over at least three times daily to prevent injury to the seed. Temperatures of 110° to 120° F., if not too long continued, are not injurious and hasten the drying out of the seed. Curing is completed in from two to three weeks, although during rainy seasons a longer time is required. The seed loses from one-third to one-half its weight in the curing process, depending largely upon the stage of maturity when harvested.

Bluegrass seed, except in limited quantities for local use, must be cleaned before it is ready for the ultimate consumer. There are half a dozen or more plants for cleaning in Kentucky and a smaller number in the Missouri area. It is not necessary to describe cleaning machinery in much detail. It is much more elaborate and complicated than the machinery used to clean other farm seeds. As a matter of fact bluegrass-seed cleaning machinery both threshes and cleans the seed. The threshing is done mainly by rubbing cylinders which break up the filaments that hold the seeds and loosen the chaff. After this the seed is separated out by the use of ordinary cleaning machinery. In some plants a gravity grader is used to put the finishing touches on the cleaning and grading.

The weight lost in cleaning bluegrass seed varies with the crop, stage of maturity when stripped and the amount of stalks, trash, etc., present. The minimum loss is 30 per cent of its rough weight, the average probably 40 per cent and the maximum 60 per cent. The charges for cleaning seed are usually 15 cents per bushel for the rough seed which brings the cost up to 25 to 30 cents per bushel of cleaned seed.

MARKETING THE SEED

As Card points out (Ky. Exp. Sta. Bul. 247) the methods of marketing bluegrass seed differs in some respects from those

employed for most other farm products. Its localized production and specialized outlet are factors in creating this difference. Bluegrass seed is not ready for use until it has been cleaned. The growers of other farm products commonly have the choice of several outlets but bluegrass seed is always sold to dealers in the producing area who either have cleaning machinery or who can command the services of such machinery at a low cost. Bluegrass seed is disposed of by the growers, either as it comes from the strippers or it is cured on the farm and sold sometime later in the year. Sometimes farmers may hold the rough seed for a year or more if prices are low. Occasionally the farmer sells seed in the field before stripping at so much per acre or so much per bushel of green-stripped seed; the so-called contractor taking all the risks of harvesting and marketing. Most contractors strip on shares, however. They usually sell their share of seed at once and this makes up a rather large part of the green seed purchased by dealers. Possibly one-fourth to one-third of the entire crop is sold green and cured by dealers. The rest is cured on the farm. The price paid for the green seed is usually a little more than half that paid for the cured rough seed. In turn the price of cleaned seed is likely to be slightly more than twice the price of the rough dry seed. The cleaned seed is sold to wholesale dealers, jobbers and retail seed dealers all over the country and considerable is exported to Europe. Lawn making takes by far the largest part of the seed. It is the standard lawn grass of this country and the best lawn grass mixtures contain a large percentage of bluegrass seed. Even the cheaper mixtures sold by chain stores contain considerable amounts of bluegrass. The increasing number of golf courses constructed during the last few years has been a factor in increasing the demand for bluegrass seed. It is not often used on the greens but fairways are sown with it. Considerable is used for seeding public parks, cemeteries, etc. The demand for seeding pastures is not large, for, as already indicated, most bluegrass pastures are the result of natural seeding. In the bluegrass regions of Kentucky, Virginia and Tennessee

seed is always sown in establishing pastures, however, and in other parts of the country the practice is increasing.

COOPERATIVE MARKETING

In 1922 bluegrass growers of Kentucky launched a cooperative marketing association, organized under the Bingham Cooperative Marketing Act. The Association was successful

FIG. 110.—Tobacco Warehouses are Often Employed in Curing Bluegrass Seed under Cover.

in pledging about 500,000 bushels of the 1922 crop and made contracts with certain dealers to clean the seed and to act as agents for selling the crop at a designated price per bushel. The seed was graded upon delivery and, as is the method in all cooperative associations, the members were paid according to the grade of seed delivered. The seed crop of 1922 was a very large one and the method of selling adopted did not prove very satisfactory in disposing of the seed. How-

ever, in February, 1923, sales permitted a distribution to growers of about 50 cents per bushel on rough seed delivered. The 1923 crop was a normal crop and while not pooled was largely controlled by the Association, a fact which enabled the Association to successfully dispose of the balance of the 1922 crop. Most of it was bought by several large dealers in Kentucky. The final payment to the Association members was made in 1924, the total payments amounting to $1.35 per bushel net for rough seed, a very satisfactory price. The 1922 crop was the only one pooled, however, as the Association found it impossible to arrange for cleaning and storing the seed at a satisfactory price. Since bluegrass seed is produced in such restricted areas it should be relatively easy to handle the crop cooperatively. Probably a well-managed association would be of much benefit to growers, as it could render many services to the industry, such as increasing the outlet for blue grassseed, lending its efforts toward improving seed quality and lessening market costs.

PRODUCTION AND PRICES

The total production of cured seed varies greatly from year to year depending both upon the season and the price of the seed. If the price is high it is often profitable to strip fields where the yield is low. If prices are low only the best fields will be stripped. The largest yield recorded in Kentucky was that of 1912, estimated at 1,500,000 bushels of rough-cured seed, equal to probably 1,000,000 bushels of cleaned seed. The following year only 175,000 bushels were produced. The 1926 crop was again an exceptionally large one. Perhaps the normal crop may be considered as around 400,000 bushels for Kentucky and from 200,000 to 250,000 in the Missouri area. Production in the Missouri area can undoubtedly be increased enormously, as this is a large territory. The prices paid growers for rough-cured seed naturally varies almost as much as the production. For the past ten years prices have been relatively high, not dropping below $1.25 per bushel at any time with the

exception of 1916. The average price during this period has been around $1.75 per bushel, and for the ten-year period preceding around 75 cents per bushel. Bluegrass seed retains its vitality for three or four years and frequently the influence of a bumper crop will be felt on the market for some time. The huge 1912 crop held down prices for several years depsite the small crops which followed. Prices paid for the 1926 rough seed

Fig. 111.—Hauling Bluegrass Seed to Market, a Familiar Sight on the Roads of the Kentucky Bluegrass Region.

were very good, considering the large crop, which indicates a good demand for cleaned seed.

The relationship between prices paid farmers for rough seed and the wholesale price of cleaned seed is not constant by any means, as might be supposed. Sometimes the dealers overestimate the demand for seed and pay more for the rough seed than the price of cleaned seed justifies. On the other hand an unexpected heavy demand will send prices of cleaned seed up where it may bring three times as much as was paid for the rough seed. Some crops of seed clean out only 35 to 40 per

cent, while in other years the return is 65 to 70 per cent. This explains the varying relationship. Possibly over a long period of years the price of cleaned seed will be just about twice that of the rough seed. In recent years the tendency has been to widen this ratio somewhat. In 1926, for example, farmers received $1.25 per bushel for rough seed. The wholesale price of cleaned seed is about $1.75 per bushel.

Bluegrass seed is stored and handled in burlap bags of fair quality holding 112 pounds each or 8 bushels.

MARKET GRADES, SEED PURITY AND GERMINATION

The legal weight of bluegrass seed is 14 pounds per bushel and this weight is used whether the seed is green, rough-cured or recleaned. This weight presumably was determined upon when cleaning machinery was not as efficient as at present. The modern plants turn out seed weighing up to 28 pounds per bushel or even higher and practically all the seed produced for domestic use weighs either 19 or 21 pounds. In some years, however, when the seed lacks plumpness 15- and 17-pound seed is produced. Foreign markets demand seed weighing 20 to 24 pounds. There is left, after all good seed is removed, some material which has the appearance of seed, but which is really chaff and does not contain 1 per cent of viable seed. Strange to say, there is often a demand for this. It is mixed with a few good bluegrass and other grass seeds, put in packages and sold by unscrupulous dealers as lawn seed.

The heavier grades of seed contain only about 20 per cent of inert material, chiefly chaff, which cannot be removed without the waste of some good seed. It is possible, however, to get seed of approximately 100 per cent purity. Nineteen-pound seed runs about 80 per cent purity; 21-pound, a little higher. Weed seeds consist chiefly of oval sedge and sour dock, but so efficient is the cleaning machinery that good seed seldom contains over half of 1 per cent of weed seeds. Sour dock is classed as a noxious weed in most state seed laws.

Commercial bluegrass seed has had, until recent years, a notoriously poor reputation as regards viability. It was seldom that samples gave a germination test of over 25 per cent and often less than 10 per cent germinated. This was believed, to be due almost entirely to poor handling in curing which permitted the temperatures in the curing ricks to get very high. Undoubtedly this did occur frequently, but it is probable that the seed was seldom as poor as the early germination tests indicated. Probably the use of modern methods of testing the seed which makes use of varying temperatures and light would have given a higher test in many cases. In recent years, largely through the efforts of seedsmen, seed has been much more carefully cured and the average germination test is decidedly better. In the hundreds of tests made at the seed laboratory of the Kentucky Experiment Station the average germination varies from 60 to 70 per cent. Bluegrass seed will not germinate for some time after harvesting and full germination is not obtained until December or January. The time allowed for a germination test is twenty-eight days, but most of the seeds germinate within fifteen days.

THE FUTURE OF THE BLUEGRASS-SEED INDUSTRY

The production of bluegrass seed at the present time is ample to meet all demands for seed at a price satisfactory to growers; consequently there is no argument for increasing production until a wider outlet for the seed develops. There is no question but what much more bluegrass seed would be used in this country if people were fully aware of the possibility of establishing lawns quickly through the use of high-grade bluegrass seed or of getting a good stand of bluegrass in pastures in a relatively short time. The more extensive use of it in seeding pastures would alone increase the demand by many thousands of bushels. To bring this about a good deal of advertising would have to be done and this could be undertaken only through cooperative efforts of dealers or through a producers'

marketing association. Just how effective advertising would be in increasing cannot be estimated. Probably it would have to be continued for several years to show striking results. Production can be greatly increased if growers can be assured of a fair average price from year to year. It can be increased both by devoting more land to stripping and by giving the seed fields greater care. If the dealers will create the demand the producers will furnish an ample supply,—of this we may be quite sure.

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CHAPTER X

THE PRODUCTION OF SEED OF TIMOTHY, REDTOP AND OTHER GRASSES

TIMOTHY SEED PRODUCTION

Timothy is the most widely grown and most important hay grass of the United States and Canada. It is best adapted to northern localities of cool, moist climate and does best on fertile, moisture retentive clays, clay loams, and loams. It is most widely grown in the northern Corn Belt States, northern and New England States, the irrigated regions of the Northwest, and in lower Canada.

Timothy is highly valued as a feed for horses and in spite of the diminishing number of horses in the cities, it remains the most important commercial hay.

The high-yielding ability, wide adaptation, dependability, abundance, purity, and cheapness of timothy seed are factors which maintain this crop in high rank in spite of the low nutritive value of timothy hay and the comparative inferiority of timothy as a pasture. The importance of timothy is proportionate to the use of horses in furnishing power and as horses decrease in number, timothy will become of less and less importance.

In growing timothy for seed, the factors of primary importance are the planting of clean seed on an adapted loam, clay loam, or silt loam, which is free of weeds. Seedings are usually made at the rate of 8 to 12 pounds of timothy seed per acre in the fall with wheat or rye. The seed is applied with a grass-seeder attachment on the grain drill and should be dropped ahead of the grain drills so as to be covered.

In the northern part of the timothy region, seedings are often made in the spring on wheat or rye or with oats or barley. Planting timothy in the fall without a grain crop on a well-prepared, thoroughly compacted seed bed gives best results in the central Corn Belt and in the western irrigated regions. In northern states, timothy is often planted in the spring with red clover or mixed with red, mammoth, or alsike clover. After two years, the red and manmoth clover disappears for the most part.

For seed purposes, timothy is usually planted without mixing with clover. The white fleabane, ox-eye daisy, sorrel, dock, Canada thistle, and catchfly, are some of the weeds which ripen seed with timothy and cause greatest loss in seed quality.

Harvesting the seed crop.—Timothy is an abundant and sure seed yielder, yielding from 5 to 14 bushels per acre. Cleanest and most abundant seed crops usually result the third year after planting. If fields are allowed to remain after the fourth year, weed infestation increases and seed yields are less and carry a higher percentage of impurity. The crop is cut when the seed is in the dough, by use of a grain binder. The sheaves are stood in uncapped shocks in the field for a period of a week or more, until cured. They are then threshed or stacked or put in the mow for threshing at a later date. The ordinary grain separator equipped with timothy seed screens is used. Over-ripe timothy shatters easily, causing loss of seed. In harvesting the crop for seed, weedy areas should be cut and raked up separately and used for hay, or at least should be threshed separately from the main crop.

Timothy seed is produced chiefly in Illinois, Iowa, Minnesota, Kansas, South Dakota, Ohio, Indiana, Michigan, and Wisconsin.

Improved strains of timothy, both for seed and forage yields, have been developed by plant breeders, particularly by Webber of the Cornell Station. These strains must be isolated from other timothies to prevent cross-pollination. While improved timothy varieties have not become of commercial

importance, due to ease of mixing and to public apathy, such strains are well worth the attention of timothy-seed growers.

The market is well supplied with timothy seed as a rule, and with alfalfa and other legumes gaining in importance, and automobiles and trucks largely replacing horses in town and

Fig. 112.—Harvesting Timothy Seed in Ohio. (C. A. Bingham, U. S. Dept. Agric.)

city, the acreage of timothy hay may be expected to continue to decrease.

REDTOP FOR SEED

Nearly all of the commercial supply of redtop seed is produced in southern Illinois, but for hay, pasture and lawn purposes redtop is widely used. As a hay grass, it is second to timothy and as a lawn grass, redtop ranks next to bluegrass in use. Redtop will give better results than timothy on poorly

drained land. It is also better adapted to acid soils than ordinary grasses and will withstand drought to a greater degree than timothy. Redtop forms an excellent turf which withstands pasturing. It produces good hay yields and is esteemed as a lawn grass. In regions where well adapted, it comes in naturally. When planted for seed, from 14 to 30 pounds are used per acre. Redtop is commonly seeded with Kentucky bluegrass for lawns, and with timothy and clover for hay and pasture, particularly on wet land. The seed weighs 14 pounds per bushel, unhulled, and 36 pounds when recleaned. Redtop chaff, consisting of the empty hull and a small per cent of seed has a place on the market and is sold at values frequently far beyond the value of the seed contained. Such chaff or " flowers of redtop " is used as a filler in making up cheap seed mixtures, a practice which is to be severely condemned. Unless carrying enough germinable seed to be of value, Redtop chaff should be destroyed in protection of the sale of good grass seed and its use in making up cheap mixtures discontinued.

Ox-eye daisy, sorrel, and buckhorn are common weeds of redtop. In handling for seed, weedy areas should be cut and removed for hay before the seed crop is harvested. Old weedy meadows should be plowed and planted to cultivated crops to clean up the weeds.

In harvesting seed of redtop, rotary strippers such as are employed in harvesting Kentucky bluegrass seed are largely used, though the old practice of cutting with mower when the panicles are brown and curing in small cocks is still in use in southern Illinois. Threshing is accomplished with an ordinary separator equipped with special redtop seed screens.

CANADA BLUEGRASS-SEED PRODUCTION

Canada bluegrass is found mostly in northern states and Canada. It has flat stems while those of Kentucky bluegrass are round. Its panicle is more compact than that of Kentucky bluegrass and color a darker green. The seed is much like that

of Kentucky bluegrass in superficial appearance. It is much more likely to carry Canada thistle prickles and seeds, and usually is of a lighter color. When closely examined, Canada bluegrass seed will be found to be a of different shape than the Kentucky bluegrass seed. The seeds of Canada bluegrass are usually broad and blunt at one end, with less pronounced veins in the lemma. The seed of Kentucky bluegrass are broad at the center, tapering to both ends. Canadian bluegrass produces seed abundantly and seed is usually available at a cheaper price than Kentucky bluegrass seed. Nearly the entire commercial supply of Canada bluegrass is produced in Ontario. In seeding, from 12 to 15 pounds of seed are used per acre.

Harvesting Canada bluegrass seed.—When the heads turn yellow the seed is mature, and the crop is cut with a mower, windrowed with a side delivery rake, and forked into small high cocks for curing. It should not be allowed to remain too long in the field and if a thresher is not available for threshing a week or ten days after cutting, the seed crop should be stacked or mowed. Threshing is done with a grain separator equipped with special screens. From 200 to 600 pounds of seed per acre are usually secured. The seed ranges in weight from 14 to 24 pounds per bushel.

Since Canada bluegrass ripens with spring wheat, a large proportion of the commercial supply is secured by the use of special screens which separate the bluegrass seed at the time the spring wheat is threshed.

Importance.—Canada bluegrass is now found over nearly the entire bluegrass country. It is not as valuable for pasture and lawns in the Corn Belt and Northern States as Kentucky bluegrass but in New York, New England, and Canada, it withstands winter better and is superior on cold, wet soils. Canada bluegrass also is superior to Kentucky bluegrass in drought resistance and is used for pastures, lawns, and golf courses under conditions too dry for successful Kentucky bluegrass sods.

GROWING ORCHARD GRASS FOR SEED

Orchard grass is best adapted to clays and clay loams but will do fairly well on sandy loam soils. It is more resistant to both wet and dry conditions than timothy. It is much better adapted to growing in shady places than timothy. As a pasture grass it makes an earlier start in the spring.

FIG. 113.—An Enlarged View of a Sample of High-quality Orchard Grass Seed. (Photo by Prof. R. H. Pettit, Michigan Exp. Sta.)

For seed production it is seeded in early spring at the rate of 12 to 16 pounds per acre, seeding on winter wheat or rye, or with spring-planted oats or barley. It is cut for hay when the panicles turn yellow and shatter slightly when bent between the fingers. An ordinary grain binder is used, the crop being tied in small bundles. These are cured in uncapped shocks for several weeks. Threshing is done usually from the field, using an ordinary separator with orchard grass riddles. Weeds should be pulled or cut before the crop is harvested, or weedy shocks thrown aside when threshing. Yields of 8 to 10 bushels per acre are considered good.

Orchard grass is grown for seed in Kentucky (chiefly Jefferson, Oldham, and Shelby counties), Clinton and Highland counties, Ohio, and Clark County, Indiana. Small amounts are grown in Virginia and Michigan. Orchard grass seed is imported in quantity from Europe and New Zealand.

MEADOW FESCUE

The production of meadow fescue seed has developed in the United States in a limited area in eastern Kansas to supply a small domestic demand and a larger export market.

This grass is used to some extent in pasture and meadow mixtures throughout the timothy-growing areas of the United States. It produces a more even sod than timothy, and being deeper rooted, withstands drought better, and furnishes a longer range of pasturage. As a meadow grass, it is a moderate hay producer.

In growing the seed crop in eastern Kansas, from 10 to 12 pounds of seed is planted per acre on a clean, firm seed bed in fall or early spring. The crop is cut for seed with a grain binder, when the heads turn brown in July, and cured in the field in small shocks. An ordinary grain separator equipped with special screens is used in threshing.

Yields of from ten to twenty bushels result during average seasons. Most of the seed crop is shipped to Europe.

CHAPTER XI

COTTON-SEED PRODUCTION

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Pure-bred cotton seed is fundamental to the cotton industry. Cotton lint produced from pure seed is much more uniform in quality and length than lint produced from mixed seed. In the days of large cotton plantations, cotton was usually ginned on the farm and the mixing of varieties was less common than at present when practically all cotton is ginned by public gins.

The most important considerations in producing a profitable crop of cotton in the past has been good tillage and fertilization. The quality of the seed planted was given very little consideration as the varieties were kept fairly pure and the farmer was not paid a premium for uniform cotton on the market.

Cotton manufacturers have always recognized the economy of uniform cotton and are usually willing to pay a premium for it on the market. The curb buyer or merchant who bought directly from the farmer seldom ever graded accurately and usually never considered the uniformity and length of staple as a factor in the price. Thus the method used in buying cotton in the past has not encouraged farmers to produce uniform cotton and has resulted in cotton becoming more and more mixed and variable.

Cotton mills have been buying the most uniform cotton on the market through expert cotton classers who buy on sample from cotton brokers or cooperative organizations. The mills have found that a sample of cotton drawn from a bale does not always indicate the true spinning value of the cotton. A bale

of cotton produced from "gin run" seed or mixed cotton will show considerable variation in quality and length of lint. Uniformity in cotton lint is very essential in the process of spinning good cotton yarn. Most cotton mills are so designed as to use only certain lengths and grade of cotton so that variable cotton results in a high percentage of waste and the quality of the yarn or cloth is unsatisfactory.

The cotton farmers belonging to cooperative buying and

Fig. 114.—A Good Seed Plant of Cotton. Note the large number of open bolls. An essential characteristic, under boll-weevil conditions. (North Carolina Exp. Sta.)

selling organizations are now receiving a premium for quality and uniformity. Manufacturers are becoming more exacting in their requirements, which has forced buyers of cotton in the open market to recognize quality and pay the producer accordingly. Pure-bred seed, which is essential in producing uniformity and quality in cotton, has taken on a new significance in the production of cotton best suited to the present and future demands of the market.

VARIETIES OF COTTON

A careful survey of the varieties grown in the Cotton Belt would show that there is over 400 named or so-called varieties of cotton. Often a variety will bear one or more names even in the same community. This state of affairs is very confusing and often misleading.

There are several different classifications for cotton varieties, all have their good points, but no one is entirely satisfactory. Cotton varieties are difficult to describe and identify. This is due to constant mixing by cross-fertilization and careless handling of the seed. Changes in the characteristics of varieties have been made by breeding in order to evade the cotton boll weevil. This in many cases has completely changed the original characteristics of a variety.

American Upland cotton is naturally grouped into long-staple and short-staple cottons. Long-staple cotton includes all varieties that produce fiber $1\frac{1}{8}$ inch in length and longer, and short-staple cotton includes varieties that produce lint less than $1\frac{1}{8}$ inch in length. The majority of cotton grown in this country is classed as short staple. The most profitable varieties in the Cotton Belt produce fiber measuring $\frac{15}{16}$ to $1\frac{1}{16}$ inches in length. Varieties of cotton may be further classified as to earliness, size of boll, character of plant, habits of growth, etc.

The most popular varieties in various sections of the Cotton Belt are constantly changing. This may be due to the activity of seedsmen, the result of an unfavorable season, invasion of the cotton boll weevil, or to a special demand on the market. A review of the results of variety tests conducted by the State Agricultural Experiment Stations, will show a large number of varieties under test at every station. The most commonly grown varieties of the Cotton Belt grouped as to length of staple are as follows:

Varieties producing less than $1\frac{1}{8}$-inch staple:

Cleveland, Mexican, Rowden, Triumph, Lone Star, Cooks, King, and Trice.

Varieties producing at least $1\frac{1}{8}$-inch staple:
Webber, Express, Delfos, Acala, Dixie, Durango, Mead, and Delta type.

According to Collings, the two most extensively grown varieties west of the Mississippi River are Mebane and Lone Star, and the leading variety east of the Mississippi, the Wannamaker–Cleveland.

COTTON VARIETIES DEGENERATE

Cotton varieties degenerate very rapidly if no care is taken to keep the seed pure, and when seed selection is not practiced,

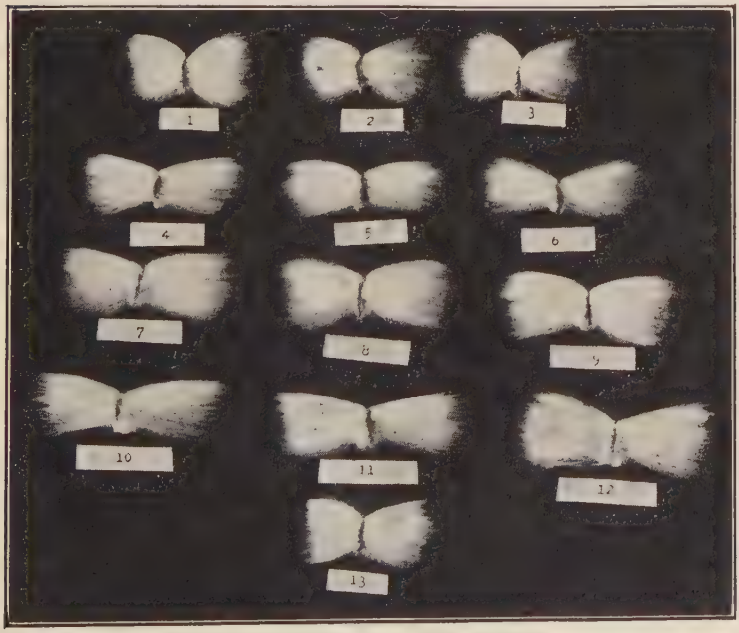

FIG. 115.—Variation in Length of Staple Produced by Strains Isolated from a Single Variety. Length of lint ranging from $\frac{5}{8}$ to $1\frac{1}{8}$ inches. (North Carolina Exp. Sta.)

pure-bred seed, will show marked deterioration after two or three years' use for the general crop.

The amount of deterioration in pure-bred cotton seed when used for the general crop is indicated by the results of an experiment conducted by the North Carolina Agricultural Experiment Station.

In the spring of 1917 the cotton farmers of Hertford County, North Carolina, planted pure seed of the Wannamaker–Cleveland variety with splendid results. Being pleased with the variety the growers continued to use this seed for the general crop of 1918, 1919, and 1920. Most of these farmers did not practice seed selection during these years. In 1921 the unselected seed of four different communities was compared with the pure seed that had been grown by a farmer who practiced seed selection each year. The results are as follows:

TABLE I

Comparison of Selected and Unselected Seed of a Pure-bred Variety of Cotton, after Three Years in the General Crop (North Carolina Agricultural Experiment Station, 1921)

Communities	Selected seed		Unselected seed	
	Lint cotton, Pounds per acre	Seed, Pounds per acre	Lint cotton, Pounds per acre	Seed, Pounds per acre
Community No. 1.....	554	966	475	845
Community No. 2.....	658	1042	585	885
Community No. 3.....	437	683	340	540
Community No. 4.....	488	762	398	627
Average.....	534	863	449	724
Increase per acre due to selected seed.....	851 lbs.	139 lbs.		

The value of the gain in lint and seed for the selected seed was $24.42 per acre, based on lint and seed prices of that year.

Since seed selection is necessary in maintaining a pure variety and seldom increases the yield, this gain represents the deterioration of unselected seed over a period of three years. The results of this test also indicate that farmers who do not practice seed selection should renew their seed every two or three years for the best results.

MIXING OF COTTON VARIETIES

Cotton varieties become mixed largely by mechanical means. No doubt the greatest amount of mixing occurs at public gins. The modern cotton gin is not constructed with an idea of saving pure seed. A very common practice among small cotton farmers is to gin a bale of cotton as soon as sufficient seed cotton is picked. This means that about 35 pounds of seed, that makes up the seed roll in the gin stand, is mixed through the seed of the following crop. Investigations by the United States Department of Agriculture show that more than 15 per cent of mixture in the seed may occur while ginning the first bale that follows cotton of another crop. Considerable mixture may occur in the second, third and even in the fourth bale, especially if the seed is not dropped in front of the gin stand, but allowed to be conveyed in the usual manner.

Varieties of cotton are often mixed by careless handling of the seed on the farm. Many farmers still practice the growing of more than one variety, in such cases there is always more or less mixing of the seed.

Cotton may become badly mixed by cross-pollenization. Cross-fertilization is brought about by bees and insects that visit the flowers. According to investigations, cotton plants may cross to the extent of 10 to 15 per cent. The amount of crossing varies as to the activity of the insects and the distance between varieties or plants. Pure varieties of cotton are thus contaminated by neighboring fields of different varieties and by mixtures often found within the variety. Experimental results show that the only remedy for " running out " or degen-

eration in cotton varieties is to maintain the purity and quality of a variety by constant selection.

ADAPTED SEED ESSENTIAL

The adaptation of cotton varieties for given conditions is very essential. It is as important to plant cotton seed of known origin and adaptation as for any other seed crop. The climatic and soil conditions in the Cotton Belt are extremely variable. The effect of climate and soils on cotton is so marked that cotton grown in certain regions is easily distinguished on the market and often given a regional name. The growing season in the Cotton Belt varies from 200 to 260 days, the rainfall from 23 to 60 inches and the average summer temperature ranges from 74° to 96° F. The variation in type of soil is also very marked. Cotton may be successfully grown on light sandy soils, silty loams to heavy clays. Satisfactory yields of cotton depend largely on how well the variety is adapted to the soil and climatic conditions. The better varieties grown in any community are usually the result of several years of adaptation and selection.

Variety tests conducted by the North Carolina Agricultural Experiment Station using the same varieties and sources of seed in more than 100 well-scattered tests, show that the comparative yields of the same variety may vary considerably, depending on its adaptation. It should be stated, however, that varieties of cotton are not affected by changes of soil and climate to the extent often noted in many other varieties of crops. Cotton varieties are usually adapted to comparatively large areas, thus insuring sufficient demand for the profitable production of pure-bred cotton seed.

COTTON BREEDING

The cotton plant offers great possibilities for the plant breeder. While cotton breeding has not reached the stage of development as for many other crops, the results obtained

during the last quarter century have been remarkable and indicate the possibilities in cotton breeding for the future.

Early cotton breeders spent much of their time crossing cotton, the object being to combine the desirable characters of two or more varieties. This method of breeding gave some remarkable results, but owing to the large number of hybrid plants produced and the necessity of considerable subsequent selection, this method was found to be slow and costly. Owing to the structure of the reproductive cells, crossing results in a very

FIG. 116.—Variation in Disease Resistance. The variety to the left is susceptible to cotton wilt. To the right a variety showing marked resistance to the disease. (North Carolina Exp. Sta.)

large number of combinations. Most of these combinations are mediocre or undesirable and much care must be taken in isolating out the better types that will breed true.

Plant breeders have found that there is sufficient variation in most commercial varieties, in fact, even in pure-bred varieties, to justify selection without stimulating a greater variation by hybridization. Plants from the same strain or variety when grown over a series of years may show a wide variation for yield, per cent of lint, length of staple, earliness, size of boll,

disease resistance and many other characters. Experiments have shown that plants from the same strain may show a variation of 20 to 30 per cent in yield and as much as $\frac{1}{4}$-inch variation in length of staple. The per cent of lint and the earliness of plants vary in proportion.

Cotton improvement at the present time is being done largely by various methods of selection, in fact it might safely be said that practically all the best strains and varieties have been developed by such means. Even though a variety may be the result of a cross, it has taken many years of close selection to eliminate the inferior strains and fix the type. There are three important steps in cotton improvement, namely: First: Selection of the best variety by test. Second: Securing representative seed of this variety and third: Improvement by selection.

VARIETY TESTING

Variety testing is the necessary preliminary work for all crop improvement. A variety test is the only means of determining the variety best suited to given conditions of soil and climate. It indicates the variety most suitable for further selection and breeding, and may be used as a means of measuring progress of all breeding work.

The essentials of a desirable variety are: First: Yield of lint cotton. Second: Length of staple. Third: Quality of lint and Fourth: Percentage of lint.

Under present marketing conditions the yield of lint cotton per acre is of first consideration in the choice of a variety. A variety that yields well must be well adapted, have desirable fruiting habits and must be disease resistant. Furthermore, under boll-weevil conditions a variety must mature early and produce a large first picking.

The length of staple is also important. Certain lengths have greater demand than others and usually command a premium on the market. Staple measuring less than $\frac{7}{8}$ inch is not worth considering from a plant-breeding standpoint. Unfor-

tunately long staples are often associated with low acre yield of lint cotton. Sufficient premium must be paid for such lengths to make up this possible loss in yield. In general, the most profitable lengths of staple to produce are from $\frac{15}{16}$ to $1\frac{1}{16}$ inches in length.

Quality of lint cotton as indicated by its strength, color and character of fiber varies as to variety. Since quality is considered an important factor in the price of cotton lint, plant breeders are now devoting more attention to it than in the past.

The percentage of lint, has always been considered associated with yield of lint per acre. Stroman, of the Texas Agricultural Experiment Station in a series of correlation studies found no relation between percentage of lint and pounds of lint per acre.

When a promising variety has been selected for further improvement, representative seed of the original variety should be secured, as the variation in the yield of the same variety grown under different conditions, may be as great as the variation in yield of unrelated varieties.

METHODS OF SELECTION

There are two general methods of seed selection used at the present time, i.e., mass selection and plant-to-row or pedigree selection. Mass selection is practiced largely by cotton growers who wish to purify and prevent their cotton from degenerating. This method of breeding consists of selecting desirable seed plants in the field, harvesting and multiplying the seed in mass, for the general crop.

The following points are considered important in making plant selections:

1. Earliness—A large number of bolls set early in the season.
2. Well-branched plants typical of the variety.
3. Short-jointed plants, branched near the ground.
4. Freedom of vegetative branches.
5. Large bolls.
6. Freedom from disease.
7. Foliage not too heavy.

The usual procedure in mass selection is to tag or mark in some manner a large number of desirable plants before the time of first picking. Before picking the general crop, the marked seed plants are reconsidered and only the most desirable picked for seed. This selected seed cotton should be ginned with a

Fig. 117.—The Staple of Improved and Unimproved Varieties of Cotton. On the left note the uniformity and length of fiber which has been the result of systematic selection. (North Carolina Exp. Sta.)

special gin so as to prevent mixing with the seed of the general crop. The following year, a seed patch is established which becomes the source of seed for the following year's general crop, and may also be used for making further selections. Mass selection is particularly adapted for use by the average farmer. It is simple and does not require a great amount of extra time.

If practiced each year, using proper precautions, a farmer should be able to maintain the purity of a variety and possibly increase his yields to some extent.

PLANT-TO-ROW METHOD OF COTTON BREEDING

The method of cotton breeding most commonly used by plant breeders is known as the plant-to-row or pedigree method. This method of selection or modifications of it, are quite generally used in the breeding of many other field crops.

The plant-to-row test is used to isolate the most desirable types within a variety or strain. Detail records may be kept of the performance of each individual selection through several generations. In this way strains can be thoroughly tested, and positive evidence obtained as to when the desirable types are fixed or will breed true.

The procedure most generally followed in plant-to-row breeding of cotton is as follows:

First Year: Field selection of desirable plants. This selection is made before the cotton flowers began to open. The plants are marked by string tags or some other means. Before picking the general crop these marked plants are carefully examined and only those meeting a certain standard for the characters desired are harvested. These promising plants are given a number, picked and the seed cotton stored in separate bags.

The cotton of each plant is ginned separately, and records made of the yield of lint and seed, length of staple, percentage of lint, lint index and character of the fiber. After the record for each selection is completed further elimination is made of all plants that are not outstanding for the desired characters.

Second Year: The seed of each selection is planted in a separate row. Records for each plant row should be made during the growing season, as to uniformity and trueness to type, earliness, branching habits, disease resistance or for any other significant character, desired. Before the cotton opens, desirable plants are again selected from the best-appearing rows.

These individuals are harvested separately and so numbered as to show the line of inheritance. After the plant rows have been harvested and the necessary data obtained, the seed from the best rows may be used for an increase plat, thus securing seed for use in the general crop. The seed plants selected and picked from the best plant-to-rows are ginned separately and further eliminations are then made as for the selections of the first year.

Third Year: Another plant-to-row test is established using

FIG. 118.—Harvesting a Plant-to-row Test of Cotton. The seed cotton from each plant-row is picked, weighed, and ginned separately. By this method of selection the most desirable strains of cotton may be isolated and developed. (North Carolina Exp. Sta.)

the best plants from the second year's plant-to-row test. After making the various observations and determinations, the seed from the most desirable row or rows are saved for the next year's increase patch and possibly for further selection.

The procedure after the third year may vary as to results obtained and to the economic importance of further selection. The plant-to-row test method of selection using the improved strains as a basis, may be expected to give further results. How-

ever, the results will not be so marked as for the first three years. Careful rogueing out of undesirable types as they appear under field conditions will possibly be all that is necessary to maintain purity and yielding qualities of a variety.

Cotton breeders have obtained excellent results with this method of selection. It has been the means of improving length of staple, quality of lint, and disease resistance. Sufficient earliness has been obtained to successfully evade boll-weevil damage; this has been accomplished without materially reducing the yield.

Methods of cotton breeding as used by the plant breeder are not practical for the average farmer. Even though he has the inclination, his training along this line is insufficient. It is more satisfactory for the average cotton farmer to buy his seed from a recognized breeder, or crop improvement association. If a farmer produces 25–30 acres of cotton each year, he may buy as little as 2 bushels of improved seed each year, and by planting this in an increase plat, develop enough seed for his entire crop the following year. By using this plan, his seed for the general crop would be only one year removed from the plant breeder. The cost of maintaining pure-bred seed in this manner would be comparatively low.

HYBRIDIZATION AS A MEANS OF IMPROVEMENT

In the past it was the popular opinion that desirable characters of two varieties of cotton could be combined in a new strain by simply crossing the varieties. This has resulted in much crossing of varieties in the past. While some very satisfactory results have been obtained, this work has been done in a hit-or-miss fashion, as comparatively little is yet known of the genetic behavior of cotton. This promiscuous crossing in the past may account for the large number of cotton varieties now in existence and may also explain in a way, the wide variation in types of plants found within many varieties.

The possibility of hybridization is no doubt very great. This field of work offers the plant breeder of the future great

possibilities. However, hybridization cannot be effectively done until more is known about the inheritance of the various characters in cotton.

COMMUNITY COTTON IMPROVEMENT

Cotton farmers throughout the South have been urged by the United States Department of Agriculture and various state Agriculture Experiment Stations to organize one-variety communities for the purpose of maintaining and developing pure-bred cotton seed. The breeding of pure-bred varieties of cotton can have little effect on improving the cotton of a state or community, if pure-seed stocks are not maintained in sufficient quantities for general planting.

Community organizations for the purpose of growing pure-bred cotton of a standard variety have many advantages, which has resulted in a rapid increase in the number of such communities, being formed throughout the cotton states.

Some of the advantages of a community organization are as follows:

1. Maintains a supply of pure-bred seed.
2. Prevents " running out " of cotton varieties.
3. Pure-bred seed is produced at lower cost.
4. The quality of production is standardized resulting in creating a special demand and better prices.
5. Results in improved cultural methods of production for the community.
6. Reduces loss due to cotton boll-weevil.
7. Results in greater returns from cotton seed.

A pure-bred variety of cotton grown in a community along with other varieties, will soon deteriorate by the mixing of seed at the gin and by crossing of various varieties in the community. Results obtained by the North Carolina Experiment Station (Table I), page 194, shows the amount of degeneration that would be expected to occur when a pure variety is grown for three years in the average cotton-growing community.

Experts in the cotton industry quite generally attribute the low grade of American cotton to the unorganized condition of the farmers who produce the seed. Degeneration of cotton varieties, the result of mixing in communities growing many different varieties, is the basis for the belief that any variety soon "runs out" and that fresh seed must be obtained. In reality, the changing of seed results in hastening degeneration, as it introduces into the community still more varieties that will eventually mix with those already in use. Thus it can be seen that the only way to prevent cotton "running out" and to maintain a sufficient supply of pure seed will be to organize the community for the purpose of growing a single pure-bred variety.

The community must be of sufficient size to assure seed that is not contaminated by cross-fertilization. Large organizations can more satisfactorily make arrangements to have their seed cotton ginned, when every precaution can be taken to prevent mixing of the seed.

The maintaining of a high standard of purity in the cotton grown by a community is a problem that may be worked out in various ways. Possibly the most satisfactory method is for the organization to maintain an expert plant breeder who devotes his entire time to developing and supplying pure-bred seed. Another plan would be, for several members of an organization to agree to supply the community with pure-bred seed grown so as to meet certain requirements relative to purity, yield, length and quality of staple.

It must be remembered, however, that to breed cotton or to maintain the purity of a variety requires training and experience as well as a real interest in the work. Usually it is necessary to employ a trained breeder of cotton to develop and maintain sufficient stocks of pure-bred seed and to meet the demand for seed from the outside.

Communities that grow but one variety have the opportunity of producing a standard quality of product. If sufficient quantities are produced to attract buyers, their cotton will soon

become known on the market and command better prices. Buyers are always willing to pay better prices for cotton that has a reputation for uniformity and quality.

Cotton grown in organized counties is usually produced at a lower cost. Farmers interested in but one variety soon recognize the importance of cooperation and freely discuss with each other the most economic method of production. Problems in tillage, fertilization and boll-weevil control are more satisfactorily solved, when considered essential to welfare of a community as a whole.

In years of bad weevil infestation a one-variety community that practices similar cultural methods will be able to more effectively control the insect and produce much larger yields, than a community that grows many different varieties of cotton and practices various method of production.

Another advantage of community organization is that it affords an opportunity to develop a seed business which may be able to sell for planting practically all the cotton seed produced. All cotton seed not used for planting is sold to oil mills. The price paid for cotton seed by the oil mills is usually but one-third to one-half as much as prices obtained for seed purposes. In years when the market for cotton is poor, the seed of a pure-bred variety is often worth as much or more than the lint.

SEED CERTIFICATION

The use of certified seed is as essential in producing economical cotton yields as for any other crop, yet the amount of certified cotton seed available on the market is almost negligible.

According to Barr of the United States Department of Agriculture "there is about 500,000 tons of cotton seed used each year in planting the cotton crop. Of this amount of seed only 30 per cent is supplied through commercial channels and 70 per cent is raised on the farms where used. Much of the commercial seed is badly mixed and is often no better than 'gin run' or seed that could be secured at most any public cotton gin"

The lack of importance given to certified cotton seed is due, first, to over-production and the low prices paid for cotton since the World War. Second, the buyers of cotton have not been willing to pay a sufficient premium for uniformity and quality in cotton—third, farmers producing seed for the market have been slow to organize for the purpose of producing pure-bred seed that would have sufficient merit for certification. However, the certification of cotton seed is now being recognized as a fundamental factor in economic production of cotton.

FIG. 119.—A Uniform Field of Cotton, the Result of Pure-bred Seed. (North Carolina Exp. Sta.)

The work of certifying cotton seed may be done by independent organizations of seed producers who usually cooperate with the State Agricultural and Experiment Stations. The purpose of such an organization is to grow and distribute improved seed which has been found by test to be suitable for the conditions where it is to be grown.

Another plan which is being perfected, is for the State Department of Agriculture to supervise the inspection work and to certify seed that has complied with the standards agreed upon by

representatives of the College and Experimental Station, State Department of Agriculture, and seed producers in joint conference.

The requirements for the certification of cotton seed as submitted for consideration by the Southern Agricultural Workers, Feb., 1925, complies with the rules of the International Crop Improvement Association. Three classes of seed are designated for special recognition, namely: "Elite seed," "Registered seed," and "Certified seed." The definitions of these classes are the same as those adopted by the International Crop Improvement Association.

The requirements of the certificate of cotton seed as recommended by Dr. Wolf, Chairman of the Committee on Seed Certification of the Southern Agricultural Workers follows:

Foundation stocks.—In beginning with a variety the most careful attention must be given to the foundation seed stocks used. Such stocks must be obtained from recognized plant breeders whenever possible. In case of varieties like Rowden, and Half and Half, which may represent mass selections rather than pedigreed strains, the foundation stock must have been obtained from an absolutely dependable source. In any instance the sources of foundation stocks must have been approved by the Association.

Planting and rogueing.—At planting time great care should be used to make certain of the purity of seed used, and also that the same strains shall be used for any replanting which may be done. Careful supervision of croppers and tenants should be exercised to make sure the seed supplied is planted.

Gins and ginning.—Any standard gin will prove satisfactory for use in ginning cotton seed. However, some gins are in better condition than others for putting out clean seed without excess fiber. Some gins are equipped with boll extractors or other equipment for removing trash. Special equipment of this kind is an advantage. However, much depends on the sharpness of the saws, the correct speed of operation of the gin, and the condition of the seed cotton in order to get a clean sample of

seed. Excessive fiber, and especially bunches of fiber in the seed, is wasteful and makes planting difficult.

The gin, or the battery of gin stands where the seed is to be ginned, shall be owned, rented, or under contract, so that the person having the cotton ginned has absolute control of the

FIG. 120.—A Small Roller Cotton Gin, Used in Ginning Seed Cotton of Individual Plants and Plant-to-row Tests. (North Carolina Exp. Sta.)

method of cleaning and of operation. The Association should recognize the fact that the safest and best plan to avoid mistakes is to gin a single variety exclusively at the same gin. Frequently this is not possible even on farms of the best breeders, and other arrangements must be made.

Where different varieties may be ginned at the same gin the following method shall be followed:

1. The seed roll shall be removed from the gin stand and the entire gin stand overhauled and cleaned of foreign seed.

2. Since it is difficult to know whether augers and pipes leading from the gin stands are clean, all seed shall be dropped on the floor at the base of the gin stand and sacked.

3. When the pure-bred seed is to be ginned, several loads of cotton of the variety should be ginned at the same time; the more the better. Even after the seed roll has been removed and all pipes and augers cleaned as carefully as possible, the seed of the first bale of the variety shall be discarded and sent to the oil mill. This insures a high degree of purity of the remaining seed.

4. It is an advantage to arrange for a special day at the gin, when all of the seed of a single variety and strain may be ginned exclusively. The seed cotton after it is picked should be stored in cleaned bins or cotton houses on the plantation, or in a seed house near the gin awaiting the special day for ginning.

Reginning.—Reginning of cotton seed for planting purposes is sometimes practiced by concerns merchandising cotton seed. Reginned seed contains no excess bunches of fiber nor " stringy " seed and makes a clean sample. Reginned seed may be run through a cleaner and grader, and all light seeds and foreign matter easily removed. There is probably a prejudice on the part of some buyers against reginned seed, due chiefly to the fact that they are not familiar with it.

Cleaning and grading.—Cotton seed sold for planting purposes should be put through a good recleaner and grader. It may be possible to gin seed cotton in some well-equipped gins and get seed sufficiently clean so that further cleaning and grading may not be necessary. However, it is generally true that all cotton seed when put through a cleaner and grader will be improved in appearance and in sale value. Standard equipment for cleaning and grading cotton seed should be used by every grower. However, no amount of cleaning and grading

of cotton seed will insure a good sample of seed when such seed has been poorly ginned.

Inspection.—Field inspection will occur at any time after the first bolls begin to open and until three-fourths of the crop has been removed from the field. Gin inspection will take place at the same time.

For sample inspection, one-half peck of the seed as it comes from the gin should be forwarded to the Association Secretary within a week after the ginning. The sample will be examined for purity and soundness. It shall then be sent to the analyst of the State Seed Laboratory, who will report on germination.

State Seed Law.—Members shall comply with the State Seed Law in labeling seed. The results of the tests made by the State Seed Laboratory shall be used as a basis in labeling. Where different lots of seed of the same variety are gathered from the different pickings, or under varying weather conditions, 2 pounds of each lot should be sent direct to the State Seed Laboratory for test, each lot being properly marked for identification.

Storage.—After ginning, careful attention must be given to proper storage. Suitable warehouse facilities are essential to insure the drying and curing of the seed without heating. Seed stored in large bulk must be moved at frequent intervals from time to time after ginning, until dry, to avoid heat damage. Seed which is sacked soon after ginning may be piled in tiers, allowing a distance between the rows of sacks to permit free circulation of air. It is quite probable that insufficient attention to storage and warehousing of seed is given by most of the cotton seedsmen.

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CHAPTER XII

GROWING AND MARKETING SEED POTATOES

The extensive production of commercial seed potatoes for shipping has developed to the highest extent in northern regions of the United States and in southern Canada and in regions of comparatively high altitude in more southern localities. This

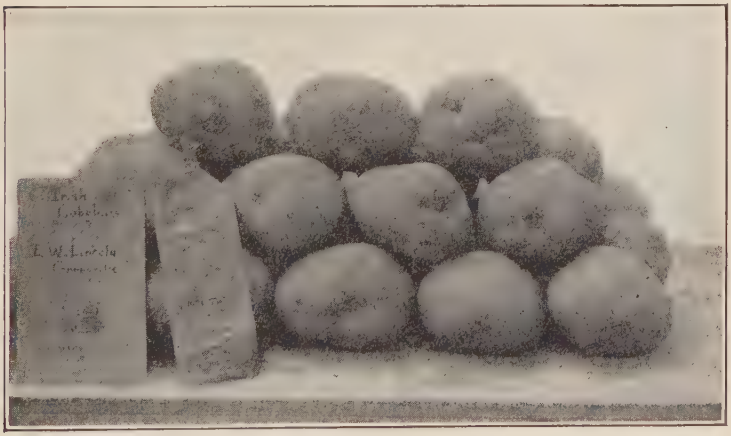

FIG. 121.—A First-prize Entry of Irish Cobbler Potatoes. (Michigan State Fair, Detroit, 1926.)

is due to the presence of a smaller degree of seed-carried diseases on northern-grown seed or seed grown at high altitudes as a class as compared to seed of central and southern localities, to the excellent winter-storage conditions of northern regions, which delay sprouting and retard rotting, and the adaptation of the climate and large areas of soil in the northern localities to the production of large yields of potatoes of high quality.

There is a tremendous annual movement of seed potatoes from Maine and other New England States and New York, Nova Scotia and Quebec to the Virginias, New Jersey, Maryland, and the coast states to the South; from Michigan, Ontario, and Wisconsin to Pennsylvania, Ohio, Indiana, Illinois, and Iowa; from Minnesota, the Dakotas, Nebraska, Montana, and Idaho to the western Corn Belt and to the Gulf States of the South.

In the Northern States, associations of potato-seed growers have been formed and in cooperation with potato specialists

FIG. 122.—Inspectors Going Over a Field of Russet Rural Potatoes Grown for Certification. Such fields must be planted with seed stock of varietal purity, and a high degree of freedom from tuber-borne diseases. The field must be carefully rogued of any diseased, or otherwise abnormal plants which may appear during growth. (Michigan.)

and plant pathologists of Agricultural Colleges and Experiment Stations, careful systems of certification, based on field and after harvest inspections and requiring a high degree of disease freedom, varietal purity and seed quality, have been developed. This **certified seed,** inspected and certified by a responsible state seed certifying organization, is the highest quality seed potato stock on the market. Seed growers in states maintaining such work find it advantageous to become members of their state Seed Potato Growers' Association or Crop Improve-

ment Association. There are many growers who sell their seed on contract to large seed dealers. Whether a member of a seed-potato growers' association or growing seed potatoes independently or on contract, the same careful methods of production, storage, and improvement will prove profitable to the grower.

Choose an adapted, improved variety in strong demand for seed purposes.—Of the six hundred or more varieties of potatoes grown in North America, six leading varietal groups produce at least 90 per cent of the crop. These leading varieties are standard in the chief potato-growing areas.

The principal late potato varieties are the Rurals, Green Mountain, and Burbank. The most widely grown early potatoes are the Irish Cobbler, Bliss Triumph, and Early Ohio. Commerically, the Rural group is the most important. Of this group, the Rural New Yorker, Carman, Sir Walter Raleigh, Petoskey, or Russet Rural are all widely grown.

The seed grower should secure the highest class of foundation stock obtainable. Certified seed from the best sources, or elite seed, developed as a result of careful plant-breeding work, should be secured. The highest possible yielding ability is desired and freedom from scab, scurf, fusarium, blight and other tuber-borne diseases.

While the late potato group is the chief table stock crop of northern states, the greater amount of seed stocks of both early and late potatoes are produced in these regions, owing to superior production and storage conditions offered.

Sort seed carefully and treat with corrosive sublimate.—The seed for the seed potato crop should be given an unusually careful sorting. All discolored, rotted, diseased, or injured tubers should be removed and the remaining potatoes freed from dirt. These seed potatoes should then be treated by soaking for thirty minutes in a corrosive sublimate solution in order to prevent or minimize injury from scab and black scurf (rhizoctonia). The corrosive sublimate (bichloride of mercury) solution is made by mixing 4 ounces of corrosive sublimate with 30 gallons of water. Wooden vessels should be used. The

potatoes are most easily handled in crates for immersion. After each treatment, one ounce of corrosive sublimate should be added to the solution and the water level left at the 30-gallon mark. After treatment, the seed should be spread in a cool well-ventilated place and allowed to dry. Crates or bags used in subsequent handling of the seed should be soaked in the solution.

Corrosive sublimate is a deadly poison and great care should be taken in disposing of the solution used and all containers.

Plant whole tubers or cut to right size.—Best results are secured from whole seed tubers ranging from 3 to 6 ounces in weight. There are no cut surfaces to hasten drying, or to offer opportunity for the entrance of spores of potato diseases. A more uniform planting is also secured from the whole seed.

A special seed plat, often planted several weeks later than the usual planting date for the market crop, is maintained by many of the best growers. The potatoes are planted closer together in the rows to secure a small average size ranging from 3 to 6 ounces. The late planting insures seed which is somewhat immature—an advantage is producing more vigorous sprouts the following season and often in greater freedom from disease. This plat is carefully rogued and the seed potatoes produced from healthy, uniform, disease-free plants. Planting whole seed gives a more uniform and vigorous stand and often results in a higher-yielding crop.

If large potatoes are used for seed, they should be cut so as to contain one or more strong eyes and each piece should weigh from $1\frac{1}{2}$ to 3 ounces. There is an advantage in the larger size for the seed crop.[1] The pieces should be blocky in order to reduce the area of cut surface, thus aiding in preventing the drying out of the seed piece. Smooth, clean, well-shaped potatoes should be used, and during the cutting process all potatoes

[1] Recent work of Mr. H. C. Moore, at the Mich. Experiment Station, shows a great reduction of hollow heart where large seed pieces (2 oz. or more) are used. Such seed pieces produce several strong shoots and much less hollow heart than in hills with only one shoot from smaller seed pieces.

having discolored flesh should be discarded. If it is necessary to hold the cut seed for several days before planting, spread out in a thin layer in a cool place, sprinkle with gypsum and turn several times a day to prevent heating.

Green sprouting increases vigor of growth and yield.—After treating whole seed with corrosive sublimate, in order to " green sprout " the tubers should be laid out in a single layer, on floors or tables, in a cool, well-ventilated, fairly well-lighted place for a period of from three to five weeks. Short green sprouts will

FIG. 123.—Seed Potatoes Properly and Improperly Sprouted. Potatoes on left were sprouted in a warm, dark storage room. The long sprouts formed break off easily and sap vitality. Potatoes on right were green sprouted in a room where temperature ranged from 35° to 40° and light was admitted. Note tightly clinging, short sprouts. (Photo by J. C. Allen, courtesy of Purdue Exp. Sta.)

develop and the potatoes will remain in a firm condition for planting. The sprouts should be stubby and strong and not easily brushed off, if the right conditions prevailed.

Opportunity is offered for discarding all potatoes with weak sprouts or which show disease. Green sprouting may hasten maturity several days or a week, hence, the green-sprouted seed may be planted several days later than seed not green sprouted.

Plant seed on clean ground, preferably a clean, well-fitted, sandy loam or loam.—Seed potatoes of best quality are produced on well-drained, fertile loams and sandy loams which are

well charged with organic matter so as to hold moisture and maintain a uniformly-growing crop during dry periods. It is important that the soil selected for a seed crop be as free as possible from the organisms of soil-carried potato diseases, such as scab and black scurf. New land, or land which has not carried potatoes for four years or more, with the potato crop following a good clover, sweet clover, or alfalfa crop, is highly desirable.

Seed potatoes, particularly seed of Irish Cobbler and other early varieties are now being grown with considerable success on well-drained muck soils. The use of potash and acid phosphate is usually necessary on such soils.

Control size by close planting.—In order to secure seed potatoes of medium size and of uniformity in shape, and to prevent or minimize hollow heart, the seed tubers should be planted in rows fairly close together with the hills closer together than for a table stock crop. The rows should be 32 to 36 inches apart, according to the fertility of the soils, and the tubers dropped in the row every 12 to 18 inches. Machine planters are usually used, the seed being planted at a depth of 3 or 4 inches.

Use proper fertilizer.—The seed potato crop will make excellent use of the right fertilizer. On the average soil of the northern states east of the Mississippi Valley, from 300 to 1000 pounds of a complete fertilizer such as a 3–12–4 or 4–12–6 will usually give best returns. On soils well supplied with organic matter, the use of from 300 to 400 pounds of 16 per cent phosphate is effective.

Manure is an excellent fertilizer for potatoes, contributing more toward the growth of the potato plant than is represented in its plant food value, owing to its effect in increasing the moisture-holding capacity of soils. From 6 to 8 tons or more of manure applied in fall or early spring, before plowing potato land, will give excellent results. Manure is deficient in phosphorus and should be supplmented by the addition of from 300 to 400 pounds of acid phosphate per acre.

Employ best cultural practices.—The seed bed for potatoes should be prepared by fall or early spring plowing to good depth

—6 or 8 inches. Breaking a good clover or alfalfa sod, which has been manured, makes an excellent start toward a high-yielding seed crop. Early plowing gives opportunity for the organic matter and manure to rot and become incorporated with the soil. The surface should be worked to an excellent condition of tilth by frequent discing and harrowing. If plowed in the spring, the cultipacker or a weighted roller should follow immediately.

The seed crop should be planted a week or more later than the table stock crop is usually planted in all but the most northern regions. As soon as the crop is planted, the field should be harrowed lengthwise of the rows with a spike-tooth harrow or weeder. Several harrowings may be given before the crop appears above ground. As soon as the plants show in the row, begin cultivation with the cultivator. The first cultivation should be close to the hills, and following cultivation shallow to prevent root pruning. Cultivations should be sufficiently frequent to keep the field clean and should cease when the plants are in full bloom. Usually three or four cultivations are sufficient.

Level culture is best except in regions where rainfall is heavy and drainage poor, in which case ridge culture is employed, the dirt being thrown into ridges over the hills to a depth of 4 to 6 inches. Ridging is also practiced under irrigation.

Spray to control insects and diseases.—In producing seed potatoes it is of the utmost importance that diseases and insects which affect the tubers be controlled. The presence of affected potatoes makes the crop undesirable for seed purposes. Protection against early and late blight, leaf hoppers and flea beetles is accomplished by thorough and frequent spraying with Bordeaux mixture. Generally four or five sprayings per season are sufficient, depending largely on weather conditions. During seasons of frequent rains, more sprayings may be necessary.

The 4–4–50 Bordeaux with one and one-half pounds of calcium arsenate per 50 gallons of solution, controls these diseases and the Colorado potato beetle. (For directions in regard to making Bordeaux Mixture, see Appendix, page 431).

The best types of spray machinery, carrying spray nozzles which distribute a fine spray on both the upper and under sides of the leaves should be used by the potato-seed grower.

Rogue seed potato fields of diseased, weak, off type, or otherwise abnormal plants.—The adequate rogueing of the potato-seed crop at frequent intervals is an essential practice in efficient potato-seed production. The seed grower must be familiar with the superficial indications of potato diseases and with the characteristics of potato varieties. When cultivating or hoeing, the grower should remove from the field and destroy diseased or abnormal plants. In addition, a careful rogueing should be given when plants are in full bloom and several times before maturity.

Mr. H. C. Moore, potato specialist of the Michigan State College, gives the following directions for effective rogueing:

"The seed plot must be rogued at least five times during the growing season. The first rougeing should be made when the plants are about 6 inches high. The final rogueing should be made just before the vines mature or before they are killed by frost.

"The grower must remove off-type, weak and diseased hills, taking both the vines and the tubers out of the field. Failure on the part of the grower to rogue his field carefully will result in the rejection of his field for certification."

Harvest the seed crop before frost injury occurs.—The seed potato crop should be harvested when early frosts have killed the vines or when mature. Damage by freezing in the ground is greatly to be feared during the average season in northern states, hence, the crop should be harvested sufficiently early to avoid risk. Harvesting should be done during clear, cool weather whenever possible. The potatoes should be allowed to lie on the ground for several hours in order to dry and toughen the skins. They should then be graded in the field and stored. Slight immaturity of the seed crop is not undesirable as such a condition may be in the case of table stock.

Store seed potatoes in well-ventilated cellars, or pits, or properly constructed storage houses.—Since seed potatoes are

generally shipped during late winter and early spring, it is necessary that they be stored under proper conditions. The potatoes placed in storage should be sound, clean and dry. The temperature of the potato-storage cellar or house must be high enough to prevent freezing and cold enough to keep tubers from sprouting. A temperature ranging between 35° to 40° F. is desirable. Adequate ventilation must be provided since potatoes in storage are constantly giving off moisture. This moist air must be drawn off and a constant and evenly regulated circulation of fresh air provided. When first put into storage,

FIG. 124.—An Efficient Seed-potato Storage Cellar in Idaho, Note Ventilators on Each Side at Top.

potatoes undergo a sweating process which raises the temperature. It is important that doors, windows, and ventilators be left open to lower the temperature at this time to prevent heating and rotting. Seed potatoes should not be stored in large piles. If the depth of the heap is 4 feet or more, special ventilators carrying deep into the pile, should be provided. Tiles may be used or "cribs" made of crates around which the potatoes are stacked. All light should be kept out of the storage cellar (except possibly during the brief period of sweating).

If stored in pits, a well-drained part of the field should be selected. It is usual to dig a trench 8 to 12 inches deep and 4 to 6 feet wide and sufficiently long to carry the crop. The potatoes are piled in a long narrow heap. Wooden flues are provided at intervals of 8 to 10 feet, and these should project well above the top. For the first few weeks, the crop is covered with 6 or 8 inches of straw with a light covering of earth. With the approach of freezing weather, the earth layer is deepened and another layer of straw added, and a foot or more of earth. During extremely cold weather, the flues are partly closed with straw to prevent freezing.

Potato-seed growers will find it advantageous to build adequate storage cellars. Sorting and shipping are much more convenient and less risk from freezing is involved.

Maintain selection work and increase plats.—The yield, uniformity and disease freedom and resistance of potatoes can be constantly improved to a more or less degree by proper selection work. Even strains supposed to be pure lines are kept in better yielding condition and often sufficiently improved in yielding ability to make selection well worth while from a breeding standpoint. The fact that the succulent tubers are hosts to numerous diseases makes such selection work necessary in developing a high degree of disease freedom in the seed which forms the foundation of the commercial seed-potato crop.

The **hill selection** and **tuber unit** methods are generally employed. In hill selecting, desirable hills are dug by hand and those carrying six or more smooth, clean, uniform potatoes are reserved for planting in an increase field the following year. By maintaining a special seed plat for such increases of an acre or more, large increases for the following year's planting on a field scale can be easily secured. The increase field is given careful rogueings.

The tuber unit method is even more effective.—One hundred or more very desirable tubers are selected, one from each of a like number of selected hills, which are harvested by hand. These tubers should be smooth, free from disease, uniform in

shape, and come from uniform, desirable, disease free hills carrying six or more marketable potatoes. The seed should be treated and planted on a selected area of soil which has not carried potatoes for six or more years. In planting, cut the tubers in four quarters, lengthwise. Drop each section at the usual distance in the row—16 or 18 inches, leave a space of 3

FIG. 125.—Hill-selection is a Valuable Practical Method of Potato Improvement. The hills are dug by hand at time of maturity and healthy, vigorous hills carrying six or more smooth, uniform, disease-free tubers of marketable size are selected for seed increase. (Courtesy Office of Visual Instruction, U. S. Dept. Agric.)

feet and drop the quarters of the next tuber and so on. A special machine planter has been developed which cuts whole tubers in quarters and plants in tuber-unit groups. Give thorough culture and sprayings. Harvest by hand. Study the product of each tuber unit. Select for increase the leading units which produce the greatest number and weight of uniform, clean, smooth potatoes. Plant, the next year, in an increase

Plant Diseases and Insect Pests of the Potato

As summarized by Professor C. E. Cormany, Michigan State College

Plant Diseases

Name	Effect on Tuber	Effect on Plant	Time of Occurrence	Hibernation	Control
Early Blight (Macrosporium solani).	Causes small tubers.	Black spots on leaves. Concentric rings around spot. Leaves die and turn black.	Occurs early in the season.	Lives over the winter on trash, etc., in the soil.	Spray with Bordeaux mixture 4–4–50
Late Blight (Phytophthora infestans).	Sunken pinkish areas. Flesh underneath is brown. Rotted flesh turns to black.	Begins on tip or edge of leaf. Dark greasy or water-soaked spots. Causes a rank odor.	Usually after blossoming.	Stays in the soil. Gets on tub erand is carried into the cellar.	Select good seed. Spray with Bordeaux mixture
Scab (Actinomyces scabies).	Causes dark scab spots. Entire potato roughened and often worthless.	Not noticed on the leaves.	Noticed when potatoes are dug.	Lives in all soils.	Rotate. Treat seed with corrosive sublimate, 4 oz., 30 gals. H_2O formaldehyde.
Black Scurf (Rhizoctonia solani).	Black lumps or spots.	Stems are reddish brown. Sunken cankers. Girdling and rotting of bark.	July or August.	Lives in the soil. Natural in forest soils.	Rotate. Corrosive sublimate
Black leg (Bacillus phytopphthorus).	Rot from the stem end. Canals or rotted pits.	Rotting of the stem, which turns black. Tissue turns soft.	First month of growth or later.	Carried in tubers grown from plants on which B. L. developed late.	Rotate. Corrosive sublimate. Seed selection.
Fusarium Wilt (Fusarium oxysporum).	Yellowish or dark staining of the vascula ring.	A wilting of the foliage. Drying of the infected portion. Stem turns brown.	Kills plant before frost as a rule.	In the soil. Found in virgin soil. On tubers.	Rotation. Seed selection.

Leaf Roll.	Small and set close to the stem. Blackening of fibers. Seed piece often found firm.	Permanently rolled and may be bronzed or reddish in color. Leaves have leathery texture.	May occur any time during the growing season.	Carried by virus in the seed.	Use disease-free seed.
Mosaic.	Decreases the yield.	Mottled leaves.	During growing season.	In the tubers.	Disease-free seed.
Streak.	No effect on tubers other than a decrease in yield.	Elongated angular spots on top of the leaflets and following the veins. Stems and leaves are very brittle when infected.	Occurs when leaves are full grown.	Tubers.	Dig out diseased hills as soon as noticed. Seed selection.
Giant Hill.	Coarse, large, and off type.	Coarse, rough foliage which remains green after the others.	Noticed before blossoming time.		Select good seed.
Witches Broom.	Small tubers.	Many sprouts and very small leaves.	As soon as they come out of the ground.	Tubers.	Proper selection.
Spindling Sprout.	Small tubers.	Weak, threadlike sprouts.	Noticed when potatoes sprout.	Tubers.	Selection.
Spindle Tuber.	Spindle shape in tuber.	Slightly more tender.	Seen in tubers at harvest time.	Tubers.	Selection.
Hopperburn (Caused by insect).	No effect directly.	Leaflets die at tips and edges.	After infested by a potato leafhopper.	Leafhopper	Use repellants for hopper.

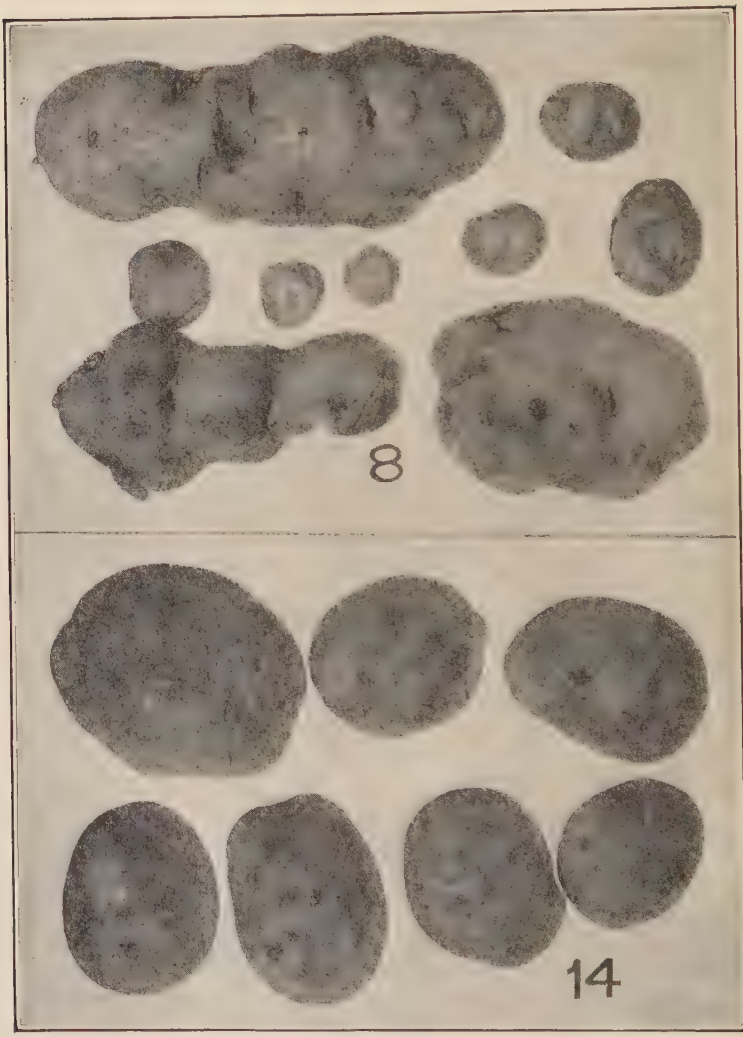

Fig. 126.—Selecting from Potato Plants Grown from Seed Balls Offers the Plant Breeder a Promising Field for the Development of Improved Varieties of Superior Quality and Disease Resistance. While the great majority of strains so secured, result in ununiform lots as No. 8 above, occasional strains of great uniformity and yielding ability result, as illustrated by No. 14. (Mich. Exp. Sta. Potato Breeding Work. Courtesy Prof. C. E. Cormany.)

plat to secure enough seed for general field planting the following year. If a tuber unit of unusual value is noted, it should be separately increased and if it proves of unusual worth, substantial increase made.

Some of the best seed growers maintain selection plats of one or two acres, or enough for their main crop the following year. Hill- or tuber unit-selected stock is used and planted three or four weeks later than the usual planting time for the table stock crop of the locality. The hills are planted 12 or 14 inches apart in rows 32 inches apart so as to secure small seed for planting whole, which will range from 3 to 6 ounces in size. These seed plats are given careful and frequent rogueing.

Seed-ball selection.—Some excellent varieties have been developed from seed balls, such as the Burbank potato developed by Luther Burbank from a selection made from plants secured from several seed balls. When seed balls are found, the seed grower should plant them himself for inspection or send them to some interested plant breeder who is on the lookout for the rarely forming seed of the potato. New and improved varieties must come largely from this source or from hybridization in the future.

GROWING SEED ROOTS, AND PLANTS OF SWEET POTATOES

Adaptation, uses, and importance:

The sweet potato is of tropical or sub-tropical origin and is best adapted to localities where there is a growing season of at least 120 days with a temperature relatively high. It is an important vegetable over a large part of the South, in many places being more extensively grown than is the common potato. It may be successfully grown in many places in the North where temperature and soil conditions are favorable. The sweet potato does not require a very fertile soil for the production of a crop, in fact a very fertile soil is not desirable as it has a tendency to produce large, coarse ill-shaped roots. The sweet potato is used for its root which is prepared for the

table much as is the tuber of the common potato. It is valuable as a canning crop, and its use for this purpose is rapidly increasing. The sweet potato is of much commercial importance; the farm value of the crop in certain years is often more than $100,000,000.

Sweet potatoes are propagated by the use of slips and by plant cuttings.

The production of choice seed stocks has been much neglected in the past, and many varieties now in common use show considerable mixtures of strains and types. Of recent years much improvement has been brought about in the way of breeding improved strains, especially in the states of New Jersey and Virginia. Seed certification is being extended to a few of the better sorts and it is quite likely that much greater improvements may be brought about within the next few years.

There are a great many varieties of sweet potatoes. According to Thompson, there are at least two hundred names given to the varieties of sweet potatoes grown in the United States, but not over forty true varieties exist. Thompson and Beattie classify these into eight groups with certain group sub-divisions. As this classification would take up much room in this discussion the reader is referred to United States Department of Agriculture, Bul. 1021, by H. C. Thompson and J. H. Beattie, entitled "Classification and Varietal Descriptions of American Varieties of Sweet Potatoes."

Sweet potatoes produced for seed purposes should possess the following characteristics:

1. They should be of a good variety and true to type for the variety.
2. They should be free from disease.
3. They should be clean and free from cuts and bruises.
4. The roots should be well matured, properly cured and held under proper conditions of storage. Seed roots of this type and character cannot fail to produce good strong, vigorous plants when grown under favorable conditions.

GROWING PLANTS OF SWEET POTATO

Select roots conforming as nearly as possible to the above-mentioned characters.

Disinfect the roots by soaking from five to ten minutes in a solution of corrosive sublimate, of a strength 1 to 1000. Rinse in clean water and place in the sun to dry.

FIG. 127.—Treating Seed Sweet Potatoes by Immersing in Corrosive-sublimate Solution. Note hot-beds for producing plants in background. (Photo by Office of Visual Instruction, U. S. Dept. Agric.)

Prepare a hot bed in a protected location which may be heated by manure, flue, or steam. Place about 4 inches of sand in bed and place the roots in position by hand, spacing them closely but not allowing them to come in contact with each other. One bushel of seed roots will cover 20–24 square feet of bed surface and will produce 2500 to 3000 plants from 2 or 3

pullings. The temperature of bed should be 80°–85° F. when roots are first bedded. It should gradually fall to 70°–75° F.

Cover the roots with 2 inches of sand and wet down thoroughly. Add more sand as soon as the plants appear. Water frequently as need may be indicated.

Pull the first crop of slips as soon as they are well rooted, and prepare for planting. Slips which appear late may be pulled when they have rooted sufficiently.

GROWING ROOTS OF SWEET POTATO

Select a warm sandy-loam soil, plow to a shallow depth and fit thoroughly. Fertilize with a complete fertilizer of a formula 2–8–6 or 2–8–8 or 3–8–8, applying at the rate of 1000 to 1500 pounds per acre.

Plant the slips after all danger of frost is over and the soil is warm. Use slips grown as previously described. If desired, a large part of the crop may be planted from cuttings taken from early planted slips. If the soil is dry, use an ample supply of water to prevent roots from drying. Space the rows 3–6 feet apart according to the variety, allowing 15 inches between plants in the row.

Cultivate frequently in order to kill weeds and to prevent formation of a crust. Cultivation may be continued until vines meet in the row.

Harvest the roots when they are fully matured.—Exercise extreme care in order that the roots be not bruised or cut in handling.

Select the best-formed tubers when picking up the crop in the field. Place in containers, and haul at once to the storage house, using a wagon provided with springs so that no bruising will take place.

Cure at the proper temperature, 85° to 90° F. When cured store at a temperature of 50°–55° F. in a dry, well-ventilated store room.

GENERAL INFORMATION ON SWEET POTATOES

History and botanical discussion:

The sweet potato is believed to be a native of tropical America. It was probably cultivated by the natives from very ancient times. The early explorers carried roots of the sweet potato to the islands of the Pacific and to tropical Asia and Africa. It has now become a very important food staple in all tropical and sub-tropical countries.

The sweet potato belongs to the *convolvulaceae* or morning glory family. In localities where frost does not damage the plant it becomes a perennial. The blossoms resemble those of the common morning glory. The sweet potato is often incorrectly referred to as a yam. The true yam is an entirely different vegetable native to tropical regions, and cultivated for its root.

Disease and insects:

Sweet potatoes are subject to many field and storage diseases. For full description and suggested measures of control see United States Department of Agriculture, Farmers' Bul. 1059, by L. L. Harter, entitled, Sweet Potato Diseases.

The sweet-potato weevil may often cause serious damage to the crop. The mature weevils feed upon the leaves and stems often girdling a plant, while the larvae eat into the flesh of the root. Roots which show infestation with weevil are not desirable for seed purposes.

CHAPTER XIII

PRODUCING SEED OF FIELD BEANS, SOYBEANS, COWPEAS, AND VETCH

GROWING SEED OF FIELD BEANS

Chose the best-adapted variety.—The leading commercial types of field beans are the Navy bean, a common white-pea bean produced chiefly in Michigan, New York, California, Wisconsin, Vermont, and Ontario, Canada; the Red and White Kidney beans of the same regions; the Great Northern white bean of Idaho; and the spotted and colored beans of California, Colorado, New Mexico, and Arizona. The Black Eye, Pinto, and Tepary are among the most common of these. Yellow-eye and Brown-eye beans are produced to some extent in New York and New England as is also the Marrowfat, a white bean larger in size than the pea-bean. The Brown Swedish is occasionally grown in Michigan and New York.

Michigan and New York State lead in the production of Navy beans, which are popular on the market as dried beans and which are favorites with canners owing to their uniform-soaking qualities and excellent flavor. About 35 per cent of the Navy bean crop is canned.

The western beans are used chiefly as dried beans for home cooking.

The demand for Red Kidney beans, particularly the dark-red kidneys, is increasing with the development of new uses. These beans are largely canned, the dark-red beans being popular in the making of attractive salad dishes and in serving on toast in restaurants.

During the past ten years, the growing of beans has become

of great importance in Idaho, nearly the entire crop being the Great Northern. Owing to the high uniformity, low pick, and good-keeping quality due to dryness, these beans are popular with grocers selling dried beans in the West and Middle West.

Plant-breeding work with beans, directed along the line of

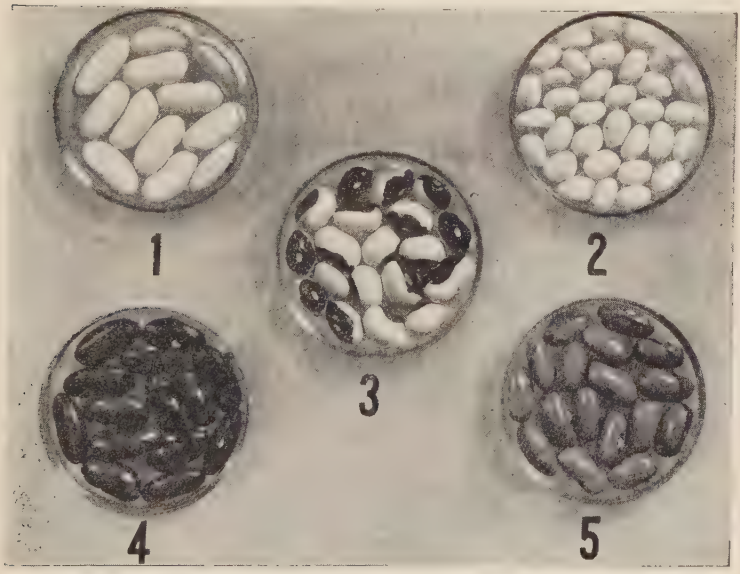

Fig. 128.—Commonly-grown Types of Commercial Beans.

(1) White kidney, (2) Navy or pea bean, (3) Yellow eye, (4) Red kidney, (5) Brown Swedish.

(Photo Courtesy H. P. Pettigrove, Bean Specialist, Mich. Exp. Sta.)

yield and quality increase, and resistance to disease, has resulted in the development of several highly improved varieties.

The Robust bean, developed at the Michigan Experiment Station by F. A. Spragg, not only outyields common pea-bean varieties but is immune to the Mosaic (a serious bean disease of New York and Michigan), and has a high resistance to blight and anthracnose, common bean diseases of the Great

Lakes and eastern bean-growing areas. The Robust was developed from a plant selection made in 1908, from a field badly injured by blight and anthracnose. This variety is somewhat later in maturing than the common pea-bean varieties and should be planted early in the season.

According to Dr. Emerson of Cornell University, the pea-bean crop of New York state was so seriously damaged by Mosaic that other crops would have replaced it were it not for the widespread production in New York of the Mosaic-resistant Robust variety.

The Wells Red Kidney bean developed at Cornell University shows a high resistance to anthracnose.

Seed growers of dark-red kidney beans are offered an unusual opportunity due to the widespread prevalence of an undesirable sport occurring in the average field crop. This sport fails to hold its color during the canning process, and the mixture of pale beans is undesirable. The seed of the sport is similar in appearance to the common dark-red kidney bean, but fortunately the plant is more upright and viney in growth and can be rogued in the field from blossom time to maturity. Seed growers who secure sport-free seed, and who keep their fields rogued, get a ready market at an advanced price for their seed.

The Great Northern variety is particularly well adapted to Idaho and neighboring northwestern states where it is grown under irrigation to a large extent. This variety apparently is not well adapted to the humid area of the Great Lakes and New England bean districts, giving extremely variable results in field tests.

Bean varieties must be selected and distributed with full knowledge of their adaptation. The varieties of the humid areas of the Great Lakes and New England States do not generally give good results in Idaho or the Southwestern States. California, New Mexico, and Arizona varieties of field beans are too late in maturing and otherwise unadapted for profitable field production in Michigan and New York.

The seed grower should grow the variety best adapted and in strongest demand in his region, being on the lookout for varietal improvements from Experiment Station plant breeders or which he or some other seed grower may develop.

Plant clean, disease-free seed.—In the humid areas of the Great Lakes and New England bean-growing territory, beans are often seriously damaged by seed-carried diseases

Fig. 129.—Hand Picking Beans in a Large Bean Elevator. Diseased beans, cracked beans, discolored and immature beans must be removed. (Belden & Co., Mich.)

which greatly decrease yields and increase the " pick " or percentage of discolored beans which must be removed by machine- and hand-picking.

The bean blight is a bacterial disease which reduces yields and causes the development of a high percentage of immature, yellowish or otherwise discolored beans. Injury from blight is lessened by planting clean seed.

The anthracnose is a fungous disease very largely seed carried. Infected seed beans show reddish or brownish spots. This disease is effectively controlled by planting clean seed from anthracnose-free fields.

The Mosaic of beans is another disease which greatly reduces yields by curtailing growth. Beans from Mosaic-infested fields show a high percentage of small immature darkened beans.

The planting of clean seed from relatively disease-free fields is necessary in growing seed beans. All diseased, discolored, and immature seed beans should be carefully picked out of the stocks of seed beans.

In the Western States, the above-named diseases cause very little loss, due to dry atmosphere conditions and a minimum of rainfall.

Plant the seed-bean crop on a thoroughly prepared seed bed and give clean cultivation.—The best seed bed for beans is one which is well settled, with the surface worked into a fine condition of tilth. Loams, silt loams, and clay loams are best adapted, though fertile sandy loam soils will give excellent yields.

Fall or early spring plowing to good depth gives best results. A clover or alfalfa sod, manured in fall or winter, makes an excellent foundation for the bean crop.

The use of acid phosphate to the extent of 250 to 350 pounds or a like amount of a 4–12–4 per acre on the phosphate-hungry soils of the central and eastern bean regions gives profitable results, particularly to the seed-bean grower. The use of acid phosphate gives an increased yield of plumper beans and also materially hastens maturity, which is quite important in regions where the fall harvest season is characterized by bad weather conditions.

Beans should be planted on a well-warmed seed bed at moderate rates for a seed crop—½ bushel or 30 pounds of white pea beans and 3 pecks of kidney beans being sufficient. A special bean drill planting in rows 28 inches apart may be used or

the ordinary grain drill employed, with every fourth drill hole allowed to run, thus planting in rows 28 inches apart. The seed should be planted at a depth of about $\frac{1}{2}$ to 1 inch.

Frequent shallow cultivations should be given, using blade or sweep-cultivator attachments so as not to injure the feeding roots. Beans should not be cultivated when wet with dew or rain, since the bean diseases, blight and anthracnose, are more easily carried from plant to plant under such conditions.

FIG. 130.—A Well-cultivated Field of Navy or White Pea Beans in Michigan.

Rogue field of diseased and off-type plants.—During later cultivations and as the crop approaches maturity, care should be taken to pull and remove from the field plants showing the effects of blight or anthracnose, or plants markedly varying in type from the variety planted. It is particularly essential that red kidney beans be rogued of the undesirable bleaching sport.

Harvest the seed-bean crop as soon as mature.—Delay in the harvesting of the seed-bean crop increases risk of discoloration due to weather injury. As soon as ripe, the crop should be pulled with the bean puller. After curing for several days, the side delivery rake is usually employed in throwing the rows into

a windrow, generally eight rows to a windrow. The bean plants are then thrown into small cocks with a pitchfork and allowed to remain until cured, when they are stacked in the mow or well-made stack until threshed. Seed beans should be stored in the mow, or if stacked, protected by a tarpaulin.

Very recently a new system of curing beans (really an adaptation of a very old practice) known as the McNaughton System of poling beans, has come into use in Michigan. This system consists of the use of ten or more steel fence posts (or pointed poles 6 feet long) per acre. The posts are loaded on the end of a wagon bed loaded with straw and the wagon driven along the side of the windrow, a post being dropped off every 8 or 10 rods, driven upright in the ground, a pad of straw about 1 foot deep and 5 feet in diameter being forked around the base. The beans from the windrow are then forked into a tall cock around the post to a height of 6 or 7 feet, 3 or 4 feet in diameter. Curing takes place under excellent conditions, even when the weather is such that beans cured in windrows or cocks would be seriously damaged. This system insures the harvest of a seed crop in good condition in spite of bad weather. The extra expense involved is approximately $3.40 per acre for the steel posts and about $1.50 per acre extra labor—cheap insurance against weather damage.

FIG. 131.—The McNaughton System of Curing Beans in Narrow Stacks, Piled on a Straw Pad at Base Around an Upright Steel Fence Post. This system insures the curing of beans with a minimum of weather-damage during unfavorable years. (Mich. Exp. Sta.)

The beaner, a two-cylinder thresher used in threshing beans,

should be thoroughly cleaned inside before threshing to remove beans from the last job from ledges and corners. Large growers of seed beans find it advantageous to own their own bean

FIG. 132.—A Small Type of Picking Machine Used by the Seed Bean or Pea Grower in Hand Picking Seed-stocks in Order to Remove Cull-beans or Peas. (Photo by J. C. Allen.)

thresher. Many also are using small types of bean pickers to aid in picking their seed beans on the farm.

GROWING SOYBEANS FOR SEED

The acreage of soybeans is undergoing a substantial annual increase in the Corn Belt States and in Virginia and the Carolinas. It is likely that this increase will continue for a number of years, increasing the active demand for seed of adapted varieties.

The soybean is not as sensitive to acid or sour soils as clover and alfalfa, hence, soybeans are being more generally grown

in regions where soil acidity places alfalfa, clover, and sweet clover on a precarious basis. Extremely acid soils must be limed for success with soybeans. The soybean crop for grain, green manuring, and hay purposes fits well in Corn Belt rotations. As a quick-growing leguminous hay crop to grow in case of clover or alfalfa failures, the soybean has no equal. The

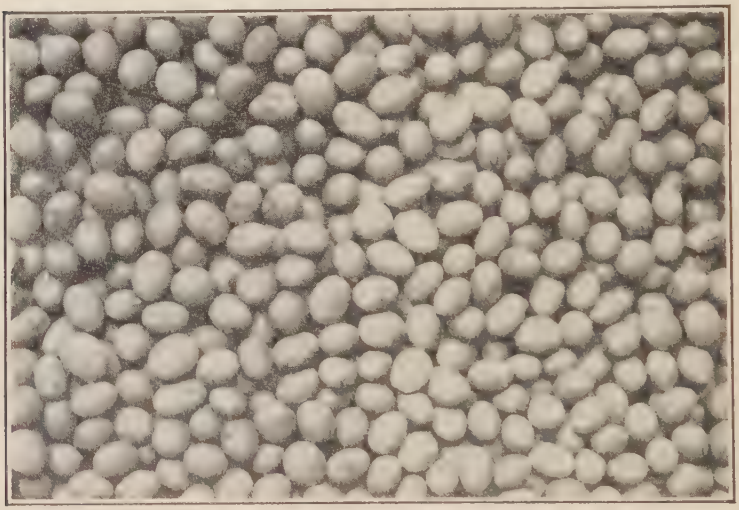

FIG. 133.—A First Prize Sample of Soybean Seed at the Chicago International Grain and Hay Show in 1925. (Courtesy J. C. Allen.)

use of soybeans for ensilage and hogging off, planted with corn, is increasing in popularity.

The soybean occupies a very similar range of territory as the corn crop, being of greatest importance in the Central and Southern range of the corn-growing region and diminishing in importance in northern corn states. As in the case of the corn crop, a large number of varieties exist, varying greatly in adaptation and yielding ability. The longer-seasoned soybean varieties of the central and southern corn regions cannot be matured in northern regions of shorter season. Short-seasoned

varieties of the North give small yields if carried South where longer-growing seasons prevail, as compared to the adapted longer-seasoned varieties.

Varieties adapted to special uses such as seed (or grain) production, hay production, growing with corn for ensilage, have been developed. It is important that soybean varieties be distributed according to their climatic and soil adaptation and the use for which they are to be employed.

Soybean varieties of greatest importance in the Corn Belt for seed purposes are the Midwest and Ito San. In Virginia and the Carolinas, the Wilson and Virginian are most widely grown. These varieties are also used for hogging off. For hay purposes in these regions, the Wilson and Manchu are preferred. In Michigan, Wisconsin, Minnesota, the Manchu, Black Eyebrow, Early Brown and Ito San are grown for both grain and forage. For forage only, the Manchu is widely grown in these states. In the southern part of the Corn Belt and in southern states, the Mammoth Yellow is the leading variety. (Note Varietal Recommendations by States, page 417.)

Growing the seed crop.—The seed bed for soybeans should be prepared in the same manner as the seed bed for corn or field beans is fitted. Fall or early spring plowing to good depth, followed by a thorough fitting with harrows and cultipacker gives a well-settled, finely surfaced seed bed. The seed should be planted when the ground is well warmed up (during corn-planting season or a few days later). Two or 3 pecks per acre, according to the size of the beans, should be drilled in rows 28 or 32 inches apart, using a corn drill with soybean plates, or an ordinary grain drill with every fourth cup open. The seed should be planted at a depth of three-fourths inch to an inch. The seed should be inoculated with the proper culture, or soil from a successful soybean field, when ground is planted to soys for the first time.

Applications of acid phosphate at the rate of 200 to 300 pounds per acre will increase yields and hasten maturity.

The crop should be given thorough cultivation, beginning

with a harrowing soon after planting and following with three or four cultivations, the first coming as soon as the rows can be followed. Subsequent cultivations should be shallow.

Harvest the seed crop as soon as pods are well filled and the seed mature and before shattering occurs. The mowing machine with buncher attachment or the grain binder is usually employed. After cutting, the crop is gathered into windrows with a side-delivery rake for curing. By handling in early morning, when damp with dew, loss from shattering is avoided. If a grain binder is used, the plants are tied into small bundles and placed in open shocks. When cured, the beans may be threshed from the shock or put in stacks or in the mow.

Threshing is done with an ordinary grain separator, with cylinder run at half-speed, or a bean separator is used. Yields of from 20 to 30 bushels per acre are considered excellent. Average yields range from 15 to 18 bushels.

After threshing, the seed should be cleaned by use of a fanning mill equipped with soybean screens in order to remove dirt, cracked seeds, and immature seeds.

Care should be taken to avoid varietal mixtures in drilling, harvesting, cleaning, storing, and handling soybean seed.

GROWING COWPEAS FOR SEED

The cowpea is of greatest importance in the Cotton Belt and is also grown to some extent in the southern part of the Corn Belt. It thrives in regions of warm seasons and is adapted to a wide range of soil. It is used chiefly for forage purposes and is the most valuable legume of southern rotations in maintaining nitrogen and organic matter in the soil. White-colored varieties are used to a large extent for food purposes.

The varieties of cowpeas are exceedingly numerous and variable in their characteristics. Some are heavy seed bearers, others produce a large vine growth and usually relatively small seed yields. The seeds are of many colors—black, buff, brown, purple, white, pink, reddish, and mottled or speckled. Many

carry a spot of black, brown or other color around the hilum. In shape, seeds are of either the crowder or kidney type. The crowder type of seed is flattened at the ends, the seeds being crowded together in the pod. The earliest varieties mature in 70 or 80 days; the later ones need 130 to 150 days.

The Whippoorwill is the most widely grown and important variety. Its seeds are of a buff color, marbled with brown. The Whippoorwill is valuable both as a forage and seed producer. It requires from 90 to 110 days for maturity.

The New Era is an early variety, maturing in from 70 to 100 days. It is comparatively bushy in growth. The seeds are buff color, speckled with blue.

The Clay is a viney type requiring 90 to 120 days for maturity. Its seeds are of buff color.

The Iron is of importance because of its resistance to rootknot and cowpea wilt. It has buff-colored seeds, is viney in its growth, and requires a long season—100 days or more for maturity.

The Brabham, a cross of Iron and Whippoorwill, also resists wilt and rootknot.

The name *Black* refers to several black-seeded varieties. In the northern areas, the Early Black is one of the most important varieties because of its earliness. This variety matures seed in 70 or 80 days. It is viney in growth and a moderate seed yielder. The common Black of the South requires 90 to 100 days to ripen.

The New Era is the most bushy in growth and one of the earliest in maturing. It has buff-colored seeds speckled with blue.

The Groit is an early variety, important in northern cowpea-growing states. It is a good forage yielder. The seeds are buff, mottled with blue and brown. This variety is a cross of New Era and Whippoorwill.

The Black Eye has white seeds with a black saddle around the hilum. It is one of the most widely grown and important varieties, being used almost entirely for human consumption.

Growing the seed crop.—Cowpeas should not be planted until the ground is thoroughly warmed up and there is little risk of frost. Comparatively early seedings made in the latter part of the corn-planting season give best results when cowpeas are grown for seed. The seed bed should be thoroughly fitted as for corn or soybeans. The seed crop should be grown in rows from 32 to 40 inches apart, and using from 15 to 30 pounds of seed per acre, according to whether the seed is of a

FIG. 134.—Harvesting Cowpeas for Seed with a Drop-rake Reaper. (Office of Visual Instruction, U. S. Dept. Agric.)

small or large-seeded variety. The use of acid phosphate or a complete fertilizer such as a 4–12–4 at the rate of 250 to 350 pounds per acre will increase seed yields and hasten maturity. Several cultivations with the ordinary corn cultivator should be given to keep the crop free of weeds.

Harvesting seed of cowpeas.—The ripening of seed is ununiform or indeterminate, and judgment must be used in harvesting when a majority of pods are ripe. Growth continues until frost occurs, with most varieties, and blossoms and green and

ripe pods may occur on the plant at all times, after the first pods are ripe. When one-half or one-third of the pods are mature is the usual time for harvesting. Hand-picking of ripe pods is often employed, but owing to the high labor cost of this method, machinery is now in more general use. The mower with buncher attachment or the self-rake reaper are generally used. Curing is accomplished by cocking in small high cocks or around poles for a week or more.

Threshing is done with the ordinary grain separator equipped with sharpened teeth on cylinders and concaves. The separator should be run at a speed which will give a minimum of cracked beans.

Yields of 15 to 30 bushels per acre can be expected from a good stand. Great care should be taken in storing seed under well-ventilated conditions so that it will dry thoroughly. If high in moisture, seed should be spread out thinly on a tight floor and stirred every few hours, or should be dried by putting over the fanning mill several times or by use of a seed drier. Seed two or more years old is usually of low vitality.

GROWING SEED OF COMMON AND WINTER VETCH

The vetches are of increasing importance as short-season green-manuring and cover crops. Varieties are numerous but the leading vetches in the United States are the common vetch, grown for seed in Oregon and utilized extensively in southern states; and the winter vetch or hairy vetch, grown to some extent for seed and forage in Michigan and other northern states, and utilized in the South for forage and green manuring. Large amounts of seed of both the common and winter vetch are imported. The vetches require a cool growing season and ample moisture.

Growing common vetch for seed.—In western Oregon and Washington, where common vetch seed is most largely grown, seed is planted in early fall, being drilled on wheat or oat stubble or broadcasted and disced in. A cleaner seed crop is secured

by fitting the ground with plow or disc and compacting with cultipacker.

September plantings give better results than later plantings. When planted alone, 40 to 80 pounds of seed is used per acre. If planted in spring, with oats, as is sometimes done in Oregon and other northern states, 40 pounds of seed is used with 1 bushel of oats per acre.

Harvesting the seed crop.—A mower with swather attachment is generally used. As soon as cut, the windrows are cocked for curing. Fairly early harvest, when seed pods are ripe on the lower part of the plant and well-formed above, gives largest yields by preventing loss from shattering. From 10 to 25 bushels of seed per acre are generally secured.

Seeds of common vetch are usually somewhat larger than winter vetch seed and are somewhat mottled. The seed scar of common vetch is longer and narrower than the scar of winter vetch seed.

The Southern States consume large quantities of common vetch seed. Most of the supply is imported from Europe.

Growing winter vetch for seed.—Winter vetch, also called sand vetch and hairy vetch, is hardier than the common vetch. It withstands the winter of northern states and is grown for seed in Michigan, Ontario, Wisconsin and a few other northern regions.

Seed production in Michigan is confined to the sandy loams and light sandy soils of western Michigan. The crop is planted in late August or early September with rye, using 20 pounds of vetch seed with 1 bushel of rye. The seed bed should be thoroughly fitted and compacted with a weighted roller or cultipacker. On soils which are acid, lime should be used to correct this condition. Inoculation with the proper bacterial culture for vetch is necessary when planting on ground which has not previously carried successful vetch crops. The use of acid phosphate or complete fertilizers such as a 2–12–4, using 200 to 300 pounds per acre, increases yields.

The crop is harvested by use of the grain binder—the vetch

and rye ripening together. It is cured in uncapped shocks and threshed with the ordinary grain separator. After threshing, the vetch seed is separated from the rye by use of the vetch separator. Yields of from 4 to 8 bushels of vetch per acre usually result, with from 14 to 25 bushels of rye.

Large importations of vetch seed at comparatively low prices from Europe supply the southern demand and tend to discourage extensive seed production in the United States. Domestic seed is generally of higher germination.

Winter vetch seed is frequently adulterated with common vetch. It can be distinguished from the common vetch due to the grayish color of the common and by the fact that the hilum of winter vetch is more oval or broader at the ends. Vetch seeds, which show orange, reddish, or fawn colors when crushed are not winter vetch seeds according to Piper.

FIG. 135. — A Vetch Separator, Used in Separating Vetch Seed from Rye or Wheat.

Because of the superior quality and greater dependability of domestic vetch seed, market demands are increasing, and it appears likely that seed production of winter and common vetch will increase in the United States.

CHAPTER XIV

GROWING SEED OF CUCUMBERS, MELONS, PUMPKINS AND SQUASHES

GROWING SEED OF CUCUMBERS

Adaptation, uses, and importance.—The cucumber is highly appreciated as an important vegetable in the diet. Pickles, salads, relishes, sliced cucumbers, are valued as appetizers, and for their vitamins and mineral salts. In 1925 there were 99,230 acres planted in the United States for commercial pickle production. In the same year the market gardener and the truck farmer planted 36,640 acres for sale as fresh fruit, and in addition there was a large home garden planting, the amount of which cannot be estimated. The cucumber is an important crop for the southern grower who ships large quantities to the northern market in the winter and early spring. It is also largely grown as a forcing crop in the greenhouse ranges of the North. The most important seed-producing area is in the Arkansas River valley of Colorado and in Nebraska, but in addition considerable quantities are produced in Michigan, with smaller amounts in Iowa and other central states.

Operations:

Choose varieties of highest yield and best quality.—There are three types of cucumbers in use: the pickling, the market garden, and the forcing. These are again divided into two groups: the white spine and the black spine. The fruits bearing white spines become lighter in color as they mature and when fully ripened they are often nearly white while the

ones bearing black spines assume a reddish-brown color when fully matured. These types will freely intercross.

The commercial pickle manufacturer prefers fruits of the black-spined type, while the market gardener often uses varieties of the white-spined class. The greenhouse forcer purchases a small amount of the seed which he uses, but many of these growers make a practice of saving their own seed. Special strains have been developed for forcing, but the total amount of seed used is very small in quantity.

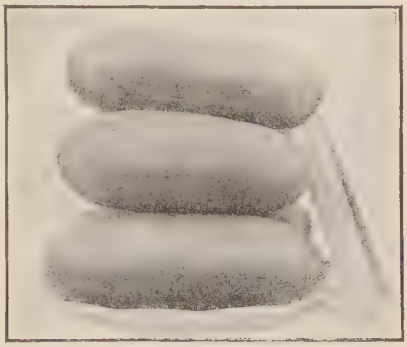

FIG. 136.—Snow's Pickling Cucumber, A Group of Ideal Fruits as Selected for Seed Stock. The individual fruits are symmetrical, of correct proportion, and perfect in shape and color.

The following table lists a number of the more popular pickling and garden varieties:

Variety	Color of spine	Length at maturity	Season	Adaptation
Boston Pickling	Black	6–7 in.	Midseason	Commercial pickling variety
Chicago Pickling	Black	6–7 in.	Midseason	Commercial pickling variety
Davis Perfect	White	10–12 in.	Midseason	Valuable truckers' variety
Earliest of All	White	7 in.	Early	Valuable truckers' variety
Early Cluster	Black	5–6 in.	Early	Useful for small pickles
Early Fortune	White	8–9 in.	Early	One of the best for the trucker
Long Green Improved	Black	12–14 in.	Midseason	Used for slicing
Snow's Perfected Pickle	Black	5–6 in.	Midseason	Perhaps the best commercial pickle

Isolate fields to prevent crossing and disease.—The cucumber belongs to the group of plants which are often cross-pollinated. There must be an intervening space of at least 40 rods

between seed fields of different varieties and a greater distance is to be preferred. There are a number of cucumber diseases which are known to be carried by insects. Isolation of seed fields will tend to help in the control of insect-borne diseases.

Select a fertile clay loam, silt loam, or loam soil.—Plow early and fit thoroughly. Harrowing with a spike-tooth harrow at frequent intervals before planting the seed will aid in control of weeds. The soil should contain an ample supply of humus, and in addition, unless it is very fertile, an application of 500 pounds per acre of a high-grade complete fertilizer will be of benefit.

Treat seed with corrosive sublimate solution or other effec-

FIG. 137.—Early Fortune Cucumber. An excellent white-spine variety for the southern trucker and the market gardener.

tive disinfectant for the control of seed-borne diseases. A number of serious cucumber diseases are known to be carried on the surface of the seed coat. Seed treatment will greatly aid in checking the spread of these diseases.

Plant in hills or in drills when the soil is well warmed and danger of frost is past.—The hills may be spaced 4 by 4 feet. If planted in drills, the rows should be spaced 4 or 5 feet apart. Use an ample amount of seed to insure a good stand. Plant the seed in moist soil, but do not cover deeply.

Control striped beetle and 12-spotted beetle with calcium arsenate and gypsum, or with a 4 per cent nicotine dust. Dust

as soon as plants appear above the ground for much damage may be caused by insects when the plants are very small.

Give first cultivation when the plants show plainly in the row, and at frequent intervals thereafter until the vines interfere with cultivation. Cultivation should be shallow at all times.

Hoe and thin to a proper stand when the plants have become well established and danger from insect injury is lessened. Thin to 3 or 4 strong plants in the hill, or if in drills, space the plants about 1 foot apart in the row.

Spray with 4–4–50 Bordeaux Mixture if there be any indication of disease. Anthracnose, angular leaf spot, and scab may be held in check by spraying. The first application may be made when the vines start to run and afterwards at intervals of ten days, if necessary. Use a power sprayer with heavy pressure and thoroughly coat the entire plant with the spray.

Rogue the field to remove off type plants.—Variations in color of fruits indicate mixtures. Fruits which vary in shape from the type of the variety should be removed.

Harvest when fully mature as indicated by the color of the fruit. It is often of advantage to delay this operation until a slight frost has destroyed the leaves. The entire crop may be harvested for seed at one time.

Thresh with a cucumber thresher.—This machine may vary somewhat in design in different growing sections but in each case the basic principles of construction are similar. There is a set of corrugated rolls to crush the fruit and a revolving wire-mesh cylinder to separate the seed and juice from the coarse rinds.

Ferment the seed in casks, vats, or pits until the pulpy coating of the seed is broken down. When a large bulk is to be handled, the pit system is the more economical. A pit of the required dimensions is prepared. This is lined with a burlap sheet to prevent discoloration of the seed by contact with the soil and to check the escape of the juice, for if the mass of seed becomes too dry while fermenting, heating will take place and the vitality of the seed may be impaired.

Wash the seed when properly fermented,[1] using a current box or a shaker washer as described for tomato. Dry the clean seed by spreading thinly on cloth-covered frames exposed to the sun, or with some type of mechanical drier. The one in most common use is constructed as follows:

A tight bin is built which has a screen floor placed about 1 foot below the top. The floor is supported by 2 by 4-inch scantlings placed at frequent intervals to prevent sagging.

FIG. 138.—Snow's Pickling Cucumber at Pickling Stage, Ranging from "Dill" Size Down to the Smallest Grades. These fruits are the identical ones selected by the Seed Committee of the National Pickle Packers' Association as representing ideal types.

Baffle boards are arranged under the floor to properly direct the current of air through the seeds. A blower fan is placed at one end to blow a current of warm air up through the seeds which are spread thickly upon the screen floor. The seeds must be stirred frequently. The temperature of the air should not be allowed to rise above 100° F. Various modifications of this machine are in use. Such a drier may be used for a wide variety of seeds.

Clean the seeds with fanning mill when thoroughly dry and store in clean sacks in a dry, well-ventilated storehouse.

[1] A process has been recently perfected for washing the seeds immediately after threshing without fermentation. It is claimed that seed cleaned in this manner has a better color and higher germination.

Maintain breeding and increase plots.—Since the cucumber is often cross-pollinated, a pure line may not be obtained through the ordinary method of single-plant selection. However, much improvement in a strain may often be obtained by selection. Select a considerable number of plants which are ideal in type. Save the seed of each plant separately and the following year plant a small test row from each selected lot of seed. It is quite likely that certain of these selected lots will prove to be superior to others. The remnant of seed from the best lot as indicated by test row, may be planted the following year in an isolated plot for further increase. To secure best results in cucumber breeding it is necessary to self-pollinate superior plants through a number of generations.

GENERAL INFORMATION

The cucumber has been under cultivation for 3000 years or more. It is considered to be a native of Asia and Africa. It belongs to the family *Cucurbitaceae* and is related to melons, squashes, and pumpkins. Although it belongs to the genus *Cucumis* as does also the muskmelon, contrary to a general belief, it will not form crosses with the muskmelon and may be safely planted in close proximity to the melon without endangering the purity of the strain.

Diseases and insects:

Bacterial wilt.—Generally the first disease to appear in the spring. It is caused by bacteria which are carried by insects, especially the striped-cucumber beetle. The plant, when attacked, will rapidly wilt. A cut stem shows a sticky exudation. This disease may be controlled by keeping insects in check and by pulling and destroying the vines as soon as they appear in the field.

Anthracnose, Angular Leaf Spot, and Scab are three distinct diseases which may attack the cucumber. They produce lesions upon the stem, leaves, and fruits, and when present to a considerable degree they may seriously injure or possibly destroy

a crop. Control measures include crop rotation, seed disinfection, and field spraying with 4–4–50 Bordeaux Mixture.

Downy Mildew may sometimes cause severe injury to the crop during warm, moist weather. Thorough spraying with Bordeaux Mixture will hold this disease in check.

Mosaic disease causes a stunting of the plant, a mottled appearance in the leaves, and a warting and discoloring of the fruits. The causal organism is unknown but it is certain that it is carried by insects, particularly by aphids. It lives over winter in a number of host plants, particularly the milkweed, pokeberry, and ground cherry. Control measures include killing insect carriers, and destroying infected host plants in the vicinity of the cucumber field.

Insects:

The striped-cucumber beetle and the 12-spotted beetle are serious insect pests of the cucumber. They feed upon the young seedling plants. The larvae attack the cucumber roots and the adult beetle is responsible for the spread of diseases. Control measures suggested are (1) covering the plants with some protecting material, (2) destroying old vines and other trash at the end of the season, (3) using trap crops, (4) applying poisons. The last-named method is the one most in use.

Melon Aphis, commonly known as "melon louse" may sometimes cause serious injury to the crop. It not only attacks the leaves but it is also believed to carry the Mosaic disease from plant to plant. It may best be held in check by dusting with a 3 per cent nicotine-impregnated dust.

GROWING SEED OF WEST INDIA GHERKIN

The West India Gherkin is a small species of cucumber. The fruits are oblong, about $1\frac{1}{2}$ inches to 2 inches long and are covered with soft prickles. It is used when very young, either cooked or pickled. Found mostly in home gardens where one or two plants will furnish enough fruits to supply an average family. It is of very minor importance as a seed crop.

There is but one variety in common use. The seeds are small and numerous. The cultural methods for production of seeds are much the same as for cucumbers.

The West India Gherkin has been found growing wild in Brazil and is probably of American origin. It grows well in the Islands of the West Indies. While closely related to the cucumber, the appearance of the vine and leaf is much different, as the leaves are small and deeply lobed. It is very prolific. One vine may produce a large number of fruits.

GROWING SEED OF MUSKMELON

Adaptation, uses, and importance.—Muskmelons are grown for market in many different sections of the United States. More than twenty states are producing and shipping melons in carload lots. As the muskmelon develops its best flavor in a hot, dry climate, a large portion of the production for shipment is centered in the dry arid regions of the West, where the crop is grown under irrigation. About 82,000 acres are planted each year to muskmelons in the United States.

Operations:

Choose seed of varieties of highest quality and best yield and which are best adapted to market demands. There is a large list of varieties in general use. Varieties differ from each other in color of flesh which may be green, white, salmon, or yellow; in size, shape, amount of netting, and smoothness of surface. The bulk of the crop grown for long-distance shipment is of the so-called Rocky Ford type which includes among the green-fleshed varieties, the Eden Gem, Extra Early Knight, and similar types. The salmon or orange-fleshed varieties of the Rocky Ford class include among the better sorts Rice's Orange Flesh, Perfecto, Pollock 10–25, Defender or Burrill Gem, Hearts of Gold, and other local strains. For nearby markets, a larger melon is often popular. The more important melons of this class are Osage, Extra Early Osage, Tip Top, Milwaukee Market, and Bender's Surprise. About nine-tenths

of the melons grown for market in New York State are of this last-named variety. The Emerald Gem is a variety which is too soft for a market melon, but by reason of its high quality it is very popular for use in home gardens. Honey Dew, Honey Ball and varieties of Cassaba melons require a long hot season for development and, hence, the production of these sorts is limited to certain restricted sections.

FIG. 139.—A Good Specimen of Bender's Surprise Muskmelon. This variety is rapidly becoming very popular as a large melon of excellent quality for near-by markets.

Isolate seed fields to prevent crossing.—There should be an intervening space of at least 40 rods between two different varieties of muskmelons which are growing for seed production. A greater distance is preferred if crossing is to be avoided.

Select a clean sandy loam or silt loam soil.—Plow early and fit the seed bed thoroughly. Apply 300 to 500 pounds per acre of a high-grade complete fertilizer and work this into the soil.

Disinfect the seed before planting with corrosive sublimate or other suitable disinfectant as recommended for cucumber.

Plant the seed when soil is thoroughly warmed and all danger of frost is past.—Plant in hills, spacing them either 4 by 4 feet or 5 by 5 feet, according to the vigor of the variety or in drills, spacing the rows 5 feet apart. Place 15 to 20 seeds in each hill or if planted in drills use at the rate of 3 pounds of seed per acre. Do not plant too deep.

Treat the plants for striped beetle as soon as they appear

above ground and at frequent intervals thereafter, using 5 per cent calcium arsenate in gypsum, or 4 per cent nicotine impregnated dust.

Give frequent shallow cultivation, starting when plants first appear above the ground and continuing until the vines meet in the row. Hand hoe, if necessary, to remove weeds from hill or row.

Thin when plants show the second true leaf, leaving two to

FIG. 140.—Making Hill Selection of Hearts of Gold Muskmelon. Type, vigor and productiveness of plant are considered as well as size, shape, and shipping quality of the fruits.

four plants in each hill, or if in drills, leave one plant for every foot of row.

Spray when plants begin to run, if necessary to control diseases such as anthracnose and angular leaf spot.

Rogue the crop to remove any off-type plants.—These may best be seen when the crop is approaching maturity.

Harvest when fully ripe, but before the fruits begin to decay. It will often be necessary to make two or more pickings in order to avoid loss.

Thresh melons through same machine used in separating cucumber seed, if produced in large lots. When small acreage is grown, or if there is necessity of close selection of fruits through inspection of color, depth, and texture of flesh, it may be feasible to cut the fruits into halves and to extract the seed by hand.

Ferment the seed for a short period, generally not to exceed three days. Wash, dry, clean, and store in the same manner as described for cucumbers.

Maintain breeding and increase plots.—Make, each year, a number of selections of superior plants, save the seed from each plant separately, test a small portion of the seed by planting in short test rows, and the following year increase the best selections by planting the seed remnants in isolated fields.

GENERAL INFORMATION

The muskmelon is believed to be a native of Asia. It belongs to the family *Cucurbitaceae* and, hence, is closely related to the cucumber and other vine crops. The common insects and diseases of the muskmelon are much the same as for the cucumber, for which see discussion under Cucumber.

GROWING SEED OF WATERMELONS

Adaptation and importance.—Watermelons are grown for market in many states, especially in the warmer sections. The average yearly acreage planted to watermelons for shipment is approximately 155,000 acres, from which are produced about 50,000 carloads. The watermelon-growing industry is apparently increasing each year.

Operations:

Choose seed of varieties of high quality which are adapted to market demands. The growers who ship long distances require varieties which have a tough rind and which will stand shipment. The more important of these varieties are—Tom

Watson, Irish Grey, Thurmond Grey, Florida Favorite, Bradford, and Georgia Rattlesnake. For nearby market, Kleckley's Sweet and Halbert Honey are recommended. Harris Early, Peerless, and Early Fordhook are excellent early sorts for the home garden.

Isolate seed fields to prevent crossing.—The watermelon, like other members of the vine group, depends upon insects for

FIG. 141.—A Selected Lot of Stock Seed Fruits of Georgia Rattle Snake Watermelon at the Bloomfield Seed Farms, Monticello, Florida. (Courtesy of Seed World.)

pollination and the pollen may be carried over considerable distances. Separate seed fields by an interval of at least 40 rods. A greater distance is to be preferred.

Choose a well-drained fertile sand or sandy-loam soil which is free from soil-borne diseases. Plow early and fit the soil thoroughly. Fertilize with a high-grade complete mixture, or if the soil is well supplied with organic matter, 16 per cent acid phosphate may be used in place of the complete fertilizer.

Sterilize the seed with corrosive sublimate solution or other effective disinfectant as recommended for cucumber.

Plant the seed when the ground is thoroughly warmed and all danger of frost is over. Space the hills 8 to 10 feet apart each way, dropping 12 to 15 seeds in each hill and covering lightly.

Treat for striped beetle as soon as the plants appear above ground and at frequent intervals thereafter as may be necessary, using calcium arsenate and gypsum or 4 per cent nicotine impregnated dust.

Give frequent shallow cultivations, starting when the plants first appear and continuing until the vines meet in the row. Hand hoe, when necessary, to remove weeds from the hills.

Thin the plants after they have become well established and danger of loss from insects has lessened, leaving from 2 to 4 strong plants in each hill.

Rogue the field to remove off types.—These may best be seen as the crop approaches maturity.

Harvest when fully mature.—Separate the seed with machine such as is used for cucumbers. If the fruits be large and solid it will be necessary to cut them into chunks before running through the crushing rolls.

Ferment in vats or pits until the seed separates readily from the pulp. This process will take longer than with muskmelons. Usually a week or more is required.

Wash, dry, clean, and store the seed in much the same manner as is described for cucumbers.

Maintain breeding and increase plots.—Much improvement in type may be brought about each year through the selection, testing, and increase of superior plants.

GENERAL INFORMATION

History and botanical description.—The watermelon is a native of Africa where it may now be found growing wild. It was introduced into the United States by the earliest settlers. It belongs to the family *Cucurbitaceae* and is closely related to the citron, with which it will readily cross.

Diseases:

The watermelon is attacked by a number of diseases including wilt, root knot, anthracnose, stem end rot, blossom end rot, and ground rot. Wilt is a destructive disease which is soil borne and may live in the ground for many years. No satisfactory method of control may be recommended. Soil which has produced wilt-infected melons should not be used again for this crop for at least ten to twelve years. Clean sanitation practices should be in use at all times.

Root knot is a very destructive disease which attacks many plants, more especially in the South. It is caused by a parasitic nematode or eelworm. A control measure suggested is the use of at least a three-year rotation, using crops in the rotation which are not subject to this parasite.

Anthracnose is a very serious disease which causes lesions on stems and leaves and which produces large spots upon the fruits. Spraying the vines with 4–4–50 Bordeaux Mixture will aid in controlling this disease. Other measures recommended are the use of disease-free seed, rotation of crops, and avoidance of cultivation when the vines are wet.

The various rots which affect the watermelon may be held in check by clean, sanitary practices, removing from the field and destroying infected plants, and spraying vines with 4–4–50 Bordeaux Mixture when disease first appears.

Insects.—The watermelon is affected by the same insects as the cucumber, for which the same control measures are recommended.

GROWING SEED OF CITRON

The citron is closely related to the watermelon. The flesh is hard and inedible. The rind is used for making sweet pickles and preserves. The fruits are sometimes fed to livestock. This fruit is of very small importance.

Choose seed of desired variety.—The seedsmen list two sorts, the green seeded and the red seeded. The fruits of these two varieties differ somewhat in shape and color.

Handle the crop throughout the growing season in the same manner as for watermelons. Harvest the fruits when ripe and chop into small pieces as the seed is extracted with difficulty. Certain seedsmen have arranged a machine for macerating the fruits of the citron which is constructed from the cylinder and concaves of an old grain separator. This does fairly effective work. The seed and pulp are fermented, washed, dried, cleaned, and stored as for watermelon.

GROWING PUMPKINS FOR SEED

Adaptation, uses, and importance:

There is no clear line drawn by the seedsmen which will completely distinguish the pumpkin from the squash. The term " pumpkin " is used to refer to members of three different species. For the following discussion, the term will be limited to varieties of the type of Connecticut field pumpkin and closely related sorts.

The pumpkin is a vegetable of minor importance to the canner, of little value to the market gardener, but popular with the general farmer as a crop which may be interplanted with corn, to be used as a stock food.

Operations:

Choose seed of best varieties.—The Connecticut field pumpkin is largely used by the canner and by the farmer for stock food. The Winter Luxury Pie, and the smaller Sugar Pie are popular varieties for the home garden.

Isolate seed fields to prevent crossing with other varieties of pumpkin and with closely related varieties of squashes which belong to the same species. These include Bush Scallop varieties, Crookneck varieties, and vegetable marrows.

Select a fertile sandy loam, loam, silt-loam, or clay-loam soil.—Plow early and fit thoroughly. Apply 300 pounds to 500 pounds of a high-grade complete fertilizer and thoroughly mix with the soil.

Plant the seed when the ground becomes warm and all danger of frost is over.—Plant in hills 8 by 10 feet or 10 by 10 feet apart, dropping ten to twelve seeds in each hill and covering lightly.

Protect from insect attack as recommended for other vine crops.

Give frequent shallow cultivations, starting when vines first appear above the ground and continuing until the vines meet in the row. After plants are well established, thin to two strong plants in each hill.

Rogue the fields to free the crop from diseased or off-type plants.

Harvest the crop when the fruits are fully mature. Cut the fruits in half and remove the seed with metal spoons. The seed may be placed in barrels and churned with a rake until freed from pulp and can then be washed at once. It will do them no harm to stand a day or two in the pulp. Wash in a current box or shaker washer dry, clean, and store as recommended for cucumber.

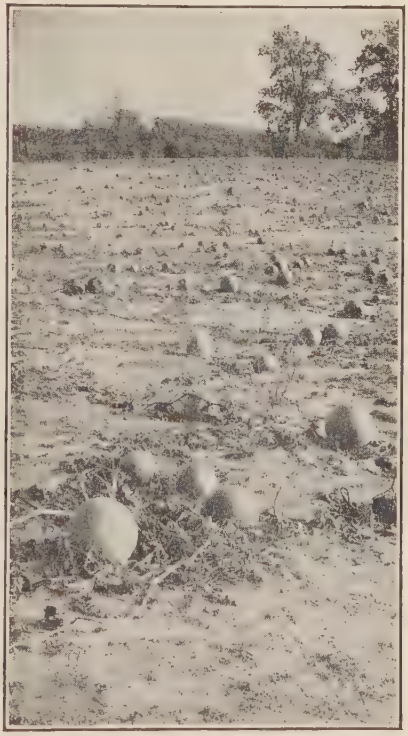

FIG. 142.—Winter Luxury Pie Pumpkin, Fruits Typically Represent the Pumpkin of the Species Cucurbita pepo.

Maintain breeding plots and increase fields to improve seed strains. The pumpkin has been somewhat neglected by the plant breeder and there is opportunity for much improvement in strains and varieties in present use. Selections should be

directed toward increasing thickness of flesh, better texture of flesh, and uniformity in size and season of maturity.

GENERAL INFORMATION

History and botanical description.—As the pumpkin is so closely related to the squash, it will be discussed in connection with that vegetable.

Diseases and insects are the same as those which attack the squash and will be discussed under that heading.

GROWING SEED OF SUMMER SQUASH, VEGETABLE MARROWS AND OTHER MEMBERS OF THE SPECIES CUCURBITA PEPO. (PUMPKIN FAMILY)

With few exceptions, the summer varieties of squashes are used while in a green or immature condition. As they mature, the rind hardens and becomes woody and the flesh breaks down into stringy fibers.

The soil and cultural requirements of this group of squashes are very much the same as for pumpkins. Plant the dwarf or bush varieties such as the bush scallops and the summer crooknecks more closely together, spacing them in hills 3 by 3 feet apart.

The scallop varieties include the small white sort and its variations; the Mammoth White Bush Scallop or Silver Custard, and other varieties which are similar in every character except color, which is yellow. There are three important varieties of the Crookneck, the Small Crookneck, the Giant Summer Crookneck and the white variations of this type.

Among the vegetable marrows, there are several English varieties which are locally grown, also an Italian variety of bush type which is sometimes known as cocozelle.

Remove the seed by cutting the fruits in halves and scooping out seed and pulp with a metal spoon. Certain seedsmen who handle summer squash seed in large quantities have evolved special types of machinery for simplifying seed handling. One

type is constructed with heavy steel rollers which crush and macerate the entire fruit. The mass is allowed to ferment for

FIG. 143.—Mammoth White Bush Scallop Summer Squash Growing for Stock Seed. (Courtesy of Jerome B. Rice Seed Co.)

a short time and the seed may then be washed. Wash, dry, clean, and store the seed in same manner as for pumpkins

GROWING TRUE SQUASHES FOR SEED

Adaptations, uses, importance: The true squashes are of greater importance than the pumpkin, although they do not rank among the more important vegetables. They are grown over a wide territory. Many home gardens include a few hills of squash. They are grown in considerable numbers by the market gardener and are grown in carload lots for the market in several states, especially Wisconsin, Michigan, New York and in certain

of the New England states. The canner often finishes up his season with a run of squash for which he usually finds a ready sale in cans.

Select varieties best adapted for the use of the gardener and canner.—The standard market variety is the Hubbard, the color of which is a dark green. Certain markets prefer a variation of this type known as the Warted Hubbard. This is somewhat larger and the shell is more heavily warted than in the true Hubbard. The Golden Hubbard has an orange-colored rind. It is somewhat earlier and a trifle smaller than true Hubbard. The Blue Hubbard is similiar in shape and size to the true Hubbard, but the shell is of a blue-gray color. The

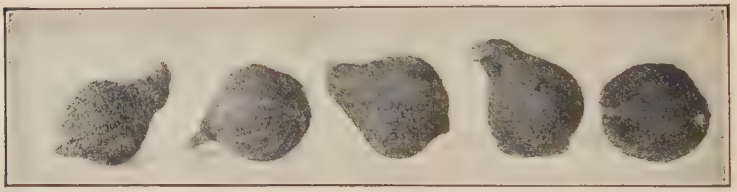

FIG. 144.—Good Breeding Methods Produced these Perfect Types of Hubbard Squash.

canner prefers the variety Boston Marrow, which has a thick flesh and is of high quality.

Isolate fields to prevent crossing.—The squash blossoms are entirely pollinated by insects, especially by different types of bees. These may fly for considerable distances and carry pollen from field to field. A 40-rod interval between varieties will greatly lessen the danger from crossing.

Follow the same practices in selecting and fitting soil, cultivation, and insect control as for pumpkins.

Rogue fields to remove off types.—The best commercial strain of seed available is likely to produce some fruits which vary from type in color or in shape.

Harvest when fruits are mature.—If gathered before frost damage, the fruits may be stored for some time without deteri-

oration and the seed may be extracted when the rush of other farm labor is over.

Remove the seed by cutting open the fruits and scraping out with metal spoon. Place seed and pulp in barrels and macerate with rake or potato hook until seed is freed from pulp. If the seed is produced in large quantities, the pulp may be loosened by spreading the mass thickly on a tight floor and treading with the feet. If rubber boots are worn, it is not likely that the seed will be injured.

Wash the seed at once without fermentation.—If the thin outer coat of the seed is injured by fermentation or other means, the corky layer underneath is likely to become discolored and the seed rendered unsalable. The seed may be washed with shaker washer as described for tomatoes, or a portion of the seed and pulp may be placed in a barrel. Water is then added and the whole mass is then stirred with a rotary motion. The seeds will come to the top and may then be skimmed off.

Spread the seed thinly on cloth-covered drying frames and dry in the sun, without stirring the seeds until they are fully dry. The outer coat will then have dried down to a thin transparent shell which will fall off, leaving the dry seed clean and white.

Clean the seed with fanning mill and store in a cool, well-ventilated storehouse.

Maintain breeding and increase plots.—Make field selections of superior type and which are productive. Save seeds of each lot separately, test and plant the best lots in isolated fields for increase as recommended for cucumbers. There is much opportunity for the plant breeder to improve squash varieties through proper breeding methods as there is much variation in the best of commercial strains.

History and botanical description:

It has never been definitely established as to whether the common varieties of squashes and pumpkins are native to the old world or the new. It is certain that they were early in

cultivation among the North American Indians and that they formed one of the staple articles of diet, and at least certain varieties of pumpkins are likely of American origin.

The pumpkins and squashes belong to the family *Cucurbitaceae*. There are three distinct species belonging to this group which differ materially from each other. The so-called true squashes belong to the species *Cucurbita maxima*. The distinguishing characters of this group are, as follows: lobes of leaves rounded, peduncle round, fruit stem not grooved but round and smooth, not enlarged at its attachment to the fruits, calyx tube bell-shaped as in *C. pepo* but not *C. moschata*. Included in this group are the Hubbard varieties, the Boston and orange marrow and the Turban types. The members of this group will freely intercross but will not cross with the members of the next group.

Cucurbita pepo—the pumpkin group. Lobes of leaves acute, indentation between them often deep, fruit stem hard, grooved longitudinally but not enlarged at its union with the fruit. This group includes the common field pumpkins, the summer squashes, the English marrows, and the Italian marrows as well as some little-known types. The members of this species will freely intercross. The third species *Cucurbita moschata* is of little importance. Some distinguishing features are—leaves soft, calyx tube very short or scarcely any, fruit stem broadly expanded at union with the fruit. This species includes Canada Crookneck, Cushaw types, Winter Crookneck, Japanese Crookneck and " Large Cheese Pumpkin."

Diseases and insects.—Pumpkins and squashes are not often seriously injured by diseases, although they may be attacked by downy mildew, and bacterial wilt. For control measures see " Cucumber."

The striped beetle is a serious insect pest of the squash. The same control measures are indicated as for cucumber.

The squash bug may cause considerable injury. It is not easily reached by poisons and is best controlled by hand picking when the vines are small. Bits of chip or shingles may be

placed under each hill. The bugs will crawl under these during the night and may easily be removed early the following morning.

The squash-vine borer tunnels in the stem near the surface of the ground and may cause a wilting and death of the vine. The plant may often be saved if the borer is cut out as soon as its presence is noted. Sanitary measures which includes cleaning up and burning old trash and vines are also recommended.

CHAPTER XV

GROWING SEED OF THE CRUCIFERS

(Cabbage, cauliflower, kohl-rabi, Brussels sprouts, kale, collards, mustard, turnip, ruta baga, radish, Chinese cabbage, species of cress, horse radish and sea kale.)

The members of the crucifer group vary widely in many respects. Some of them are annuals, producing seed during the first year. Many of them are biennials, requiring two years to produce a seed crop, while a few members of this group are hardy perennials which will live over a long period of years.

There is a wide difference as to the parts of the plant which are used for food. The cabbage, kale, and others are used for their leaves; cauliflower is used for its thickened-flower head; kohl-rabi for its thickened stem; radish, turnip, ruta-baga, and horse radish, for their roots; mustard, for both its leaves and its seeds, and sea kale for its young shoots.

The plants belonging to the species *Brassica oleraceae*, including cabbage, cauliflower, kale, kohl-rabi and Brussels sprouts, are believed to have been developed from the same type of wild plant and members of this group are so closely related that they will freely intercross and they will also form crosses with related species. This fact must be taken into account when growing seed crops, if proper isolation is to be maintained.

In general it may be said that the crucifers are heavy-feeding plants with somewhat shallow-root systems. They require for best development a soil that is rich in quickly available plant nutrients.

GROWING CABBAGE FOR SEED

Uses, adaptation, importance:

The cabbage is the most important of the leaf crops. It also ranks as one of the most important vegetables. It is grown as an early truck crop in many states, the season starting

FIG. 145.—An Excellent Field of Short Stem Ballhead Cabbage. Plants such as these cannot fail to produce good seed. (Courtesy of Seed World.)

with Florida which ships new cabbage early in February, and ending with the extreme northern states which market their first early cabbage in June and July. A vast amount of late cabbage for winter storage is grown in the Northern States, especially in New York and Wisconsin. The manufacture of sauerkraut is annually increasing in amount as the general public is becoming informed as to the healthfulness of this product. In addition to the commercial crop large quantities of cabbage are grown each

year in home gardens, few gardens being without a plentiful supply of this vegetable.

Choose varieties of highest quality which are best adapted to the use of the trade. The truck-crop grower in the South sows seed in the late fall months and carries his plants over winter in the open ground. He finds that the pointed-head varieties, Jersey Wakefield and Charleston Wakefield, will pass through the rest period of cold weather and will later resume growth and produce solid heads, while the round-head varieties, as Golden Acre and Copenhagen Market, are likely to bolt to seed if subjected to like conditions. The gardener in the North plants Golden Acre for first early, followed by Copenhagen Market and Midseason Market. For late fall and winter storage a good strain of the ball-head type, preferably one of the short-stem strains. The Penn State Ballhead, developed at the Pennsylvania Experiment Station is a very excellent strain of this type. The kraut manufacturer prefers one of the so-called, " domestic " varieties, such as All-head, or All-seasons. He also makes use of the varieties, Copenhagen Market and Glory of Enkhuisen.

In localities where the cabbage yellows disease in the soil is a limiting factor in the production of a crop, profitable crops of cabbage may be produced by the use of one of the yellows resistant strains which are now obtainable.

Disinfect the seed before sowing, using the corrosive sublimate treatment, or the hot-water treatment. There are a number of serious diseases of the cabbage which are known to be carried in the seed. While seed treatment may not entirely control seed-borne diseases, it will aid in preventing serious losses from these causes.

Select a warm, fertile, well-drained sandy-loam soil for seed bed. Plow early and fit thoroughly. Choose a location which not only has not grown a crop of cabbage recently, but which also has not grown any related crop. A number of cabbage diseases are carried in the soil, and many of them are common to all members of the cabbage group.

Sow the seed thinly in rows 12 to 15 inches apart for hand cultivation or 24 to 30 inches apart for horse cultivation. Cultivate as soon as the plants appear above the ground and hand weed the rows to keep them clean.

Protect the seedling plants from injury caused by root maggot by the use of a solution of corrosive sublimate. Three

FIG. 146.—Cabbage Seedlings Infected with Cabbage Yellows. This disease is soil borne and may be largely controlled by planting resistant varieties. (Courtesy of Dr. M. W. Gardener and Purdue University Experiment Station.)

or four applications at intervals of a week to ten days may be necessary for complete control.

Two methods of growing cabbage seed are in use in the United States. In certain sections it is customary to grow seed from mature heads. In other sections, where winter conditions are not too severe, much of the seed crop is produced from heads which are somewhat immature, as these will withstand the winter in the open ground with little protection. When the latter method is used, it is necessary that stock seed of highest quality be planted.

GROWING CABBAGE SEED FROM MATURE HEADS

Sow seed in the open ground in early May for late varieties or in June, for the extra early sorts. Cultivate and protect from root maggot as previously described.

Select a fertile loam soil and fit thoroughly.—Fertilize with

FIG. 147.—Copenhagen Market Cabbage. This is a popular early variety with round solid head and few outer leaves which permits of close planting.

a complete fertilizer of the formula 5–10–5, applying this at the rate of 500 pounds per acre and working well into the soil.

Transplant the plants to the field in late June or early July.—Use a hand trowel or a machine transplanter, spacing the rows 3 feet apart and placing the plants 2 feet apart in the row. Pack the roots thoroughly.

Give frequent shallow cultivation throughout the growing season and keep the rows free from weeds with hand hoe.

Control the cabbage worm with arsenate of lead in solution or dust.—Control the aphis with nicotine dust. A severe infestation of aphids may sometimes be prevented if the first heads which show signs of infestation are removed from the field and destroyed.

Rogue the fields to remove from the growing crop all plants which are not true to type.—Make field selections of perfect typical heads for production of seed stock.

Store the head before hard frosts.—A severe freeze while it may not seriously injure the head for market purposes, will often cause damage to the stem which will prevent rooting during the following spring. Two methods of winter storage are practiced in the East. If the trench method be used, select a well-drained site for the trench, preferably one with a northern exposure, or if conditions are favorable the trench may be made in the field where the cabbage crop was grown. Plow out a trench 1 foot deep and remove the loose soil with a shovel. Place the cabbage upright, three abreast in this trench and pack the roots and stems in soil. Cover the tops with straw, or with boards as advised for celery and above this place soil and litter to a sufficient depth to prevent freezing.

Cabbage may be successfully stored in a cleared space in forest or wood lot. Deep snows which drift in and remain late in the season will aid in protection from freezing. Select a somewhat open spot and scrape off leaves and other litter until soil is exposed, place the cabbages in rows on the ground, with the heads of one row resting in the stems of the row placed previously. Cover with the leaves and litter which were removed, and later, as the cold weather approaches, cover deeply with strawy litter.

Planting in spring.—Select a well-drained sandy loam and fit well, use a fertilizer high in phosphorus and work well into the soil.

Isolate the seed fields to prevent crossing.—Bear in mind that varieties of cabbage will not only freely intercross but will cross readily with other members of the same species such as

kale, cauliflower, and others. With all of the Brassicas, crossing will take place even though considerable distance be maintained between varieties. In order to insure purity of strain it is necessary to separate seed fields by intervals of at least 160 rods.

Lay out rows 4 to 5 feet apart and make trenches in these rows by use of ordinary plow. If the heads be large it may be necessary to deepen the furrow by returning with the plow in the same furrow.

FIG. 148.—The Club Root of Cabbage, a Soil Carried Disease. (Courtesy Botanical Dept., Purdue Agr. Exp. Sta.)

Lay the cabbage on their sides in the furrow, spacing the heads 2 to 3 feet apart. Cover the roots and pack well, leaving the upper half of the head exposed.

Make two incisions in the head at right angles to each other, with the center of the cross over the bud, in order that the bud may successfully break through. Watch the field during the first week of growth to see that the bud is not restricted by tightly compacted leaves.

Cultivate frequently and keep free from weeds.—As the plants develop and the leaves become loosened, remove these and fill in the cavities with soil in order to prevent rotting of the stem. With each cultivation the rows should be slightly ridged.

Support the plants as they develop with stakes and twine.—Place a row of stakes on each side of cabbage row and string twine between stakes.

Harvest by hand when the pods begin to turn yellow.—If left until fully mature there is likely to be much loss through shattering of seed.

Cure the crop in the field.—The plants may be laid on canvas sheets, or the supporting stakes may be pulled and laid crosswise the ridges, forming a slightly raised surface upon which the plants may be laid for curing.

Handle carefully from field to threshing floor.—Pods shatter at a touch. Use canvas-covered racks to draw the crop from field.

Thresh on canvas or tight floor with flail, or if grown in large lots a machine may be used. Clean the threshed seed with a fanning mill.

Spread the seed out thinly, until thoroughly cured and dry. Give frequent stirring. Cabbage seed stored in a moist condition will quickly mold. When dry sack and store in a cool well-ventilated storeroom.

Growing seed from immature heads.—This practice is much in use in the West where winters are not too severe. In any case, the stock seed from which the crop is grown should be produced from selected mature heads.

Time the sowing of seed, and the transplanting of the plants to the field so as to bring the plants into winter with the heads but half-formed. Space the plants in the field in rows 4 feet apart with plants 18 to 30 inches apart in the row, according to the variety.

Rogue the fields to remove all plants which are not true to the type of the variety. Many of these off types may be distinguished when the plants are quite small.

At the approach of cold weather throw a light furrow over each row with a plow, and remove this in spring.

Give frequent shallow cultivation during the second season. Harvest-cure, thresh and store the crop as previously described.

Maintain breeding and increase plats.—Select a number of perfect heads of best type and plant in an isolated field. Test the progeny of each plant separately and reserve the best strains for future increase. Many cabbage plants are seemingly self-sterile and for this reason it is likely that much of the type improvement must come from mass selection.

GENERAL INFORMATION

History, botanical discussions, kraut making, table use, value in diet:

Cabbage is native to the chalk cliffs of England and to certain portions of the mainland of Europe. It may still be found growing in its native habitat. It is one of the oldest vegetables and was probably used for food as early as 2500 B.C.

Fig. 149.—A Typical Cabbage Plant Well Loaded with Seed Pods.

Cabbage belongs to the *Cruciferae*, or mustard family. The wild form of cabbage is a hardy herbaceous perennial. The cultivated cabbage is a biennial, but it is grown for food as an annual crop. There are many widely differing types of cabbage, as they differ in size, shape, color of the leaves, in texture and in season of maturing. There are a number of strains of red cabbage. These are used in a small way in salads, and for pickling. Savoy cabbage has curled leaves. The heads are not, as a rule, as solid as some of the other varieties, but

the texture of the leaf is finer and the flavor is more delicate. If the good qualities of the Savoy cabbage were better known, this type would be more greatly appreciated for use in the home garden.

Large quantities of cabbage are used each year for the production of sauerkraut. This healthful food product is formed by the addition of about $2\frac{1}{2}$ per cent by weight of salt, to the finely shredded leaves. Lactic acid fermentation is allowed to take place up to a certain point after which air is excluded and the kraut will then keep for a considerable period.

Cabbage contains vitamins A, B, and C, but is especially rich in vitamin C. It also contains certain valuable mineral salts, hence it ranks high as a valuable part of the diet.

GROWING CAULIFLOWER SEED

Adaptation, uses, importance:

Cauliflower is somewhat more exacting in its requirements as to soil, temperature, and moisture requirements than is the cabbage. Hence, it may not be as successfully grown over so wide a range of territory. It requires a cool, moist atmosphere for best development. Cauliflower is grown for its tender heads, which are formed from the thickened portions of abortive-flower parts. There has been a considerable increase of acreage in the United States devoted to the growing of cauliflower during the past ten years. In 1925 it had reached reached a total of 15,130 acres with a farm value of $4,081,000. A large proportion of the crop was produced in four states, California leading with 6610 acres, followed by New York with 5550 acres, Oregon with 1400 acres, and Colorado with 1000 acres.

Very little cauliflower seed is produced in the United States, the bulk of the seed used being imported from northern Europe, especially from Denmark. It may be produced in certain portions of the United States, especially the Puget Sound section of Washington, but as it is a crop which requires exacting care

and the best cultural practices for the production of seed it is quite likely that much of the seed used here will be produced abroad.

Developing stock seed:

Choose highest quality and best market types of varieties. One of the most popular varieties is known as the Early Snowball. This variety is a favorite with the truck farmer and the market gardener. The Early Dwarf Erfurt is next in importance, followed by Danish Giant, or, as it is sometimes called, Dry Weather cauliflower, for the reason that it is believed to be more tolerant of dry locations. There are a number of varieties listed by the seedsmen but they are of minor importance as compared with the three leaders mentioned above.

Isolate seed fields to prevent crossing, as noted with cabbage, all members of the cabbage species will freely intercross and hence the seed fields must be widely separated.

Select the same type of soil and fertilize as described for cabbage.

Treat the seed with corrosive sublimate or other suitable disinfectant for the prevention of seed-borne disease.

Sow seed in early fall.—Winter the young plants in cold frames, protecting them from severe freezing. When growth starts in spring, transplant the plants to the field, cultivate, harvest, thresh, cure, and store the crop much in ways similar to handling the cabbage crop.

Another method sometimes followed in the West is as follows:

Sow seed in hot beds in late January or early February.—Harden the plants in cold frames and remove to the field when danger of hard frosts are over, planting the plants in rows 4 feet apart and spacing the plants 3 feet apart in the row. Cultivate and care for seed crop as recommended for cabbage.

In the East it is sometimes the practice to sow seed in early July, transplant later to the fields. At the approach of winter the partially formed heads are stored in trenches as

advised for cabbage. The roots and stems are packed in soil and the heads prevented from freezing. The plants are removed to the field in early spring and allowed to produce a seed crop.

It is possible to produce good cauliflower seed in a greenhouse. Set the plants in bench or soil bed in the position where they are to remain, and allow them to grow and mature seed without further transplanting.

GROWING SEED OF BROCCOLI

Broccoli is a vegetable much resembling cauliflower. It is classed as belonging to the same species and botanical variety as cauliflower and differs from that vegetable in that it is somewhat more hardy, it requires a much longer season for the development of the heads, and the heads are much more loose and open. Broccoli is not widely grown in America, and a large part of the seed used here is imported from Europe, although a small quantity of seed is produced in the Puget Sound district of Washington.

For seed production, sow seed in early July.—Transplant to the field in from four to six weeks. At the approach of winter dig the plants and store in trench as recommended for cabbage. Protect from freezing. Set the plants in field in early spring. Cultivate and care for seed crop much in the same manner as for cabbage. Rogue the growing fields to remove all plants that are off in type or in color. Two varieties are grown in America. The White Cape, which is white in color, and the Purple Cape, which is similar to the white except in color which is of a purple shade.

GENERAL NOTES ON CAULIFLOWER AND BROCCOLI

Cauliflower and Broccoli are descended from the wild cabbage. Many writers regard cauliflower as an advanced or improved type of Broccoli. They are alike in that both are used for their flower heads. They are considered to be

of comparatively recent origin. Cauliflower and Broccoli belong to *Cruciferae* or mustard family. They differ from cabbage in that it is the flower parts that are used for food instead of the leaves. They are subject to the same diseases and insects for which see Cabbage. The flavor of cauliflower is more delicate than that of cabbage and for this reason it is preferred by many people. It may be cooked and served in a number of ways, and it is an important ingredient of mixed pickles.

GROWING SEED OF CHINESE CABBAGE

Adaptation, uses, importance.—Chinese cabbage is grown in many localities to a small extent, but is not one of the important vegetables. For best development of the head a cool, moist climate is essential. Seed sown in spring which develop plants in the heat of midsummer will not form good heads but will bolt to seed. Seed sown in mid-July in the North will likely produce good solid heads. Chinese cabbage when cooked has a delicate flavor which is appreciated by many people. The blanched inner leaves may be served raw as a salad. Most of the seed used in America is imported from China and Japan.

GROWING STOCK SEED OF CHINESE CABBAGE

Choose varieties of best quality. Pe Tsai is one of the most popular sorts. It forms a long compact head of high quality. Wong Bok is a variety which produces a heavy compact head, somewhat shorter and broader than that of Pe Tsai. Among other varieties of merit may be listed: Chosen, Shantung, Chokurei, Kinshu, and Che-Foo.

Isolate seed fields to prevent crossing.—Select a cool, moist, rich silt loam and fit thoroughly. Fertilize with a complete fertilzer using 400 to 600 pounds per acre of a 4–8–6 mixture.

Treat seed with corrosive sublimate or other efficient disinfectant for control of disease.

Plant the seed July 15 to Aug. 1 in rows 2½ to 3 feet apart.—Thin the plants to stand 15 to 18 inches apart in the row. Give frequent shallow cultivation throughout the growing season.

Rogue in field and select typical plants for stock seed production. Remove the entire plant from field before frost damage and store in trench or cold storage. Pack the roots in soil, and protect plant from freezing.

Transplant to field in early spring in rows 3 feet apart with plants 1 to 2 feet apart apart in the rows.

Cultivate, harvest, thresh and cure the seed crop as described for turnips.

Another method sometimes used for production of stock seed is as follows:

Sow seed in February in hot beds. Transplant the plants to flats and later harden in cold frames, taking care that the plants are not subjected to a check in growth. Transplant to the field in early spring in rows 2½ to 3 feet apart. Fertilize heavily with fertilizer high in nitrogen in order to force growth before hot weather. If the spring is cool a large number of the plants will form heads. Rogue out all off types and allow only perfect heads to produce seed. Harvest and care for seed as described for turnip.

GROWING OF CHINESE CABBAGE SEED CROP FOR COMMERCIAL USE

Isolate field to prevent crossing:

Select a fertile sandy loam soil and fit thoroughly.—Fertilize with a complete fertilizer high in phosphorus. Use fields for seed production which have not recently grown cabbage, turnip or related crops.

Treat the seed with corrosive sublimate or other efficient disinfectant to destroy seed-borne disease.

Plant the seed in the spring in drills 3 feet apart and thin the plants to 1 foot apart in the row. Cultivate, harvest, thresh and cure seed as described for turnip.

GENERAL NOTES ON CHINESE CABBAGE

History botanical description, uses.—Chinese cabbage is a native of China. It is considered by many people to be a comparatively new vegetable to the United States but this is not true, for it has long been known here, although little cultivated. Fearing Burr in his description of American varieties of vegetables, published in 1865, mentions and describes two varieties which are cultivated to-day. Chinese cabbage belongs to *Cruciferae* or mustard family, although it is not a true cabbage, as it belongs to a different species. It is an annual plant with somewhat hairy outer leaves and differs in many other ways from a true cabbage. It is used as a pot herb and in salads. It is valuable in the diet in that it contains valuable mineral salts and in common with other leafy vegetables, it is rich in vitamins.

GROWING SEED OF KOHL-RABI

Adaptation, uses, importance:

Kohl-rabi is a vegetable of minor importance. It is grown to a small extent by market gardeners for nearby markets, and in home gardens. It is used for the turnip-like enlargement of the stem which is formed just above the ground. This may be diced and cooked like the turnip or the stem may be sliced thinly, dipped in batter and fried.

Kohl-rabi is closely related to the cabbage as it belongs to the same species, and it will freely cross with the cabbage.

Practically all of the seed used in the United States is produced in Europe, principally in Denmark, Holland, Germany, and France. Early Purple Vienna and Early White Vienna are leading varieties.

Seed of Kohl-rabi might easily be grown in America if the importance of the crop would warrant a development of the industry. Kohl-rabi produces seed much in the same manner as cabbage. The soil requirements are similar; cultivation, harvesting, threshing, and curing the seed is much the same

as for cabbage. Kohl-rabi is subject to the same diseases and insects as the cabbage, control measures for which are as for this crop.

Kohl-rabi is more hardy than cabbage and on the Pacific Coast it may be successfully wintered over in the open ground. In the East it will be necessary to store the plants in trenches.

Plant the seed during the middle of July. Transplant to the field in rows 3 to 4 feet apart, spacing the plants 1 to 2 feet apart in the row. Isolate the field, rogue for off types; cultivate and cure for the crop as for cabbage.

GROWING SEED OF KALE

Uses, adaptation, importance:

Kale belongs to the non-heading group of cabbage-like plants. It is one of the important plants which are grown for pot-herbs. Kale thrives best in cool weather and is largely grown as a fall crop in the North. It is an important truck crop, especially in Virginia, from whence large quantities are shipped during the winter to the northern markets.

A large portion of the kale seed used in America is imported from Europe, although it may be successfully grown wherever it is possible to grow cabbage seed, as the requirements of soil, seasonal conditions and culture are about the same. Kale is fairly hardy and in many sections will winter over with little or no protection.

Select choice seed of best varieties. Dwarf Curled Scotch, Dwarf Purple, or Brown Curled, and Tall Curled Scotch, are popular varieties. These are alike in that the leaves are finely curled. Dwarf Curled Siberian or German Greens is a very vigorous-growing variety, much in use by the market gardener. This variety is not so curled as are the Scotch sorts.

Isolate the fields.—Treat the seed with disinfectant. Select the same type of soil as for cabbage.

Plant the seed in early August in rows 3 to 4 feet apart; thin the plants to stand 2 feet apart in the row. Cultivate and

protect from disease and insects as for cabbage. In localities where there is likely to be severe winter weather, throw a ridge of soil over the row just before the ground freezes for the winter. In the West this will not be necessary.

The following spring and summer, cultivate, harvest, thresh and cure the seed much in the same manner as for cabbage.

GENERAL NOTES ON KALE

Kale has been grown as a cultivated vegetable for many centuries. It was known to the ancient Greeks. Cato, who lived about 200 B.C., describes several varieties of kale. This vegetable is said to be improved in quality if subjected to a heavy frost, and it is available for use in the garden long after most other vegetables have been killed. Kale is especially subject to severe infestations from cabbage aphids and it may be necessary to treat the plants with nicotine dust several times during the growing season in order to hold these pests in check.

GROWING SEED OF COLLARD

Collards in habit of growth and uses much resemble kale. It belongs to the same species and botanical variety as does kale. It is grown to a small extent in the South where it is used as a pot-herb. The plant grows to a height of 2 to 3 feet, producing a rosette of leaves at the top of the stalk. The small amount of seed used in the United States is produced mainly in southern Georgia.

Select a fertile sandy loam soil, fertilize and fit thoroughly. Plant the seed in drills, 3 to 4 feet apart, and thin the plants to stand 1 to 2 feet apart in the row.

Give clean cultivation and keep free from weeds. Protect from insects and diseases as for cabbage. Allow the plants to winter in the open. The following year cultivate harvest, cure and thresh the seed as for cabbage.

GROWING SEED OF BRUSSELS SPROUTS

Adaptation, uses, importance:

Brussels sprouts are closely related to the cabbage, but instead of producing a large head, many small heads are produced in the axils of the leaves along the main stem, which in some varieties reaches a height of 2 feet. Brussels sprouts are delicate in flavor when cooked, much resembling cauliflower in this respect. This vegetable was until recently grown principally by market gardeners in the North, but lately it is becoming of some importance as a winter truck crop for the South, especially in southern Louisiana. The sprouts are packed and shipped in quart boxes and are much in demand in the northern markets.

Much of the seed used in America is imported from Europe, but it is possible to produce seed of high quality in any section where cabbage seed may be grown with success.

Disinfect the seed.—Plant seed in early August. Select soil and fertilize as for cabbage. Transplant the plants to the field; dig the plants and store in trenches over winter in the East. In the West this may not be necessary.

During the second year the soil requirements and cultural conditions are much the same as for cabbage.

GROWING SEED OF TURNIP AND RUTABAGA

Uses, adaptation, importance:

Turnip differs somewhat from rutabaga, as it belongs to a different species. There is a difference in average size, in shape, in density of root, in appearance of the leaves, and in time needed to produce a crop. However, as the requirements for growing a seed crop are much alike they will be discussed together.

Choose varieties of highest quality which are adapted to the needs of the trade. There is much variation in turnip varieties. In shape, in size, in color of skin, in color of flesh,

and in form of leaf. The more important varieties are: Purple Top White Globe, a globe-shaped variety with white flesh; the skin is white below, and purple above the ground. Purple Top Strap Leaf, a white-fleshed, flattened sort, purple above and white below the ground. The leaves are entire or of the strap-leaf type, instead of pinnately divided as in other varieties. Early Snowball, Early White, and Early Purple Top Milan, are excellent extra early varieties with white flesh. Amber Globe and Golden Ball are fine yellow-fleshed sorts.

FIG. 150.—Trial Grounds are Important Adjuncts to the Seed Business in Order that Old Varieties may be Constantly under Test and New Varieties Given Careful Observation and Their Merits Determined. (Grass Lake Seed Farm, Michigan.)

White Egg is a white variety somewhat oblong in shape. Cowhorn grows long and slender, sometimes reaching a length of 2 feet. Seven-top, a variety grown in the South, does not form a root, but is used for its tops which are cooked as "greens." Many other varieties of turnip are listed by seedsmen, but the varieties named above will cover a large percentage of the important sorts.

The list of rutabaga varieties is very short. There are in general two types. The yellow-fleshed, by far the most important, and the white-fleshed, of little importance. The Improved American Purple Top is the standard variety with yellow flesh.

Many other so-called varieties differ little from this sort. It produces roots which are globe-shaped or slightly oblong. The Monarch or Tankard is quite distinct. The roots of this variety are oblong in shape with square, blocky ends. Budlong White Rock and White Sweet or Russian are leading white-fleshed sorts.

Isolate the seed plats to prevent crossing.—Varieties will freely intercross and should be widely separated.

Plant on clean soil in order to prevent soil-borne diseases, avoid fields which have recently grown crops of crucifers, as number of soil-borne diseases are common to all members of this group.

Select a fertile sandy loam or loam soil and fit throughly. Fertilize with a complete fertilizer high in potash.

Treat the seed with corrosive sublimate or other efficient disinfectant to prevent loss from seed-borne diseases.

Plant seed of turnip early in August; rutabagas, a month or six weeks earlier. In the East where the roots must be stored in winter the seed may be sown in rows 15 to 18 inches apart, for hand cultivation, or 24 to 30 inches apart for horse cultivation, thinning the plants to stand 6 to 12 inches apart in the row. In the West where it is the practice to leave the roots in the ground over winter plant the seed in rows 3 feet apart, thinning the plants to stand 12 to 15 inches apart in the row.

Give frequent clean, shallow cultivation throughout the growing season. Hand hoe the rows to free them from weeds.

Protect the plants from injury caused by aphids by use of 2 to 3 per cent nicotine dust, applying at frequent intervals.

In the East:

Remove the roots from the field before being damaged by frost. Cut off the tops, taking care not to injure the center bud. Store in pits 1 foot deep, cover the roots with straw, and then with earth to a depth sufficient to prevent freezing. Ridge the soil over the pit in order to shed water. Provide the pits with ample ventilation.

Before placing the roots in pit, sort carefully, and discard all roots which are in any way untrue to type.

Select a fertile loam soil and fit thoroughly.—Fertilize with a complete fertilizer high in phosphorus.

Transplant the roots to the field early in spring.—Plant in rows 3 feet apart, spacing them 12 to 15 inches apart in the row. Pack the root firmly in the soil and leave the center bud exposed.

Give clean shallow cultivation at frequent intervals, and keep the rows free from weeds.

Harvest the crop by hand when the pods turn yellow but before they are fully matured. If left too long there will be much loss througn shattering of seed. Place in small piles with the heads laid parallel together. Leave in field until fully cured.

Handle the plants with care while drawing from the field as the dry pods will shatter at a touch. Use a canvas-covered rack, as a large part of the seed will be threshed while loading on the wagon.

Thresh on canvas or tight floor with flail or with a properly equipped separator. Clean the seed with fanning mill and spread out thinly on canvas, stirring frequently until seed are fully cured, then sack and store in a cool, well-ventilated storeroom.

In the West:

Grow the roots as previously described.—At the approach of winter throw a ridge of soil over each row using a plow. Remove this ridge in spring; cultivate, harvest, thresh, and cure the seed as described above.

Maintain breeding and increase plots.—Select a number of the finest roots, perfect in size, shape and color. Plant these in isolated locations, save the seed from each separately, test the progeny of each, and reserve the best for increase. A choice strain may be built up very rapidly by the use of this method.

GENERAL INFORMATION ON TURNIP AND RUTABAGA

History and botanical discussion:

The turnip is believed to be a native of Russia and Siberia where it is said to be found growing wild to-day. It has been under cultivation since a very early date. The rutabaga is considered to be native to Europe. Both turnip and rutabaga are members of the family *Cruciferae* and of the genus *Brassicae* They are therefore closely related to the cabbage group.

Many of the diseases and insects pests which attack the turnip and ruta-baga are the same as for the cabbage group, hence the control measures previously mentioned will be found useful for these vegetables.

GROWING SEED OF MUSTARD

Uses, adaptation, importance:

There are several species of mustard which are used for food purposes. The white mustard is grown to a limited extent for salads and greens. The large-curled types of the varieties Giant-curled, Ostrich Plume, and Fordhook Fancy, are of a different species. These are used as pot-herbs, especially in the South. The black mustard is grown for its seed which is ground and prepared for use as a condiment.

Mustard seed is usually produced as an annual crop. Plant the seed in early spring in drills 24 inches apart, thinning the plants to 6 to 8 inches apart in the row. Isolate the seed fields to prevent crossing.

Give frequent shallow cultivation, hand hoe the rows to free them from weeds. Rogue the crop to remove all plants which are not true to the type of the variety. Use especial care to see that no wild mustard or volunteer plants are growing in, or in close proximity to, the seed field.

Harvest cure, thresh and clean the seed as described for turnip.

GROWING ROOTS OF HORSE-RADISH

Horse-radish is a plant of the family *Cruciferae* and hence is related to mustard, turnip, and radish, also to the cabbage group. It is a hardy perennial which is used for its root. While it will readily grow in almost any locality, the most important centers of commercial production are in the vicinity of St. Louis, Missouri, Illinois, New York and New Jersey. Horse-radish has a flower stem which is usually densely covered with small white flowers, but as it seldom produces seed it is propagated by the use of roots. The side roots are trimmed off as the crop is being prepared for market. These roots are tied in bundles of fifty each and are stored over winter buried in sand in a pit or in barrels of sand in a cool cellar. The roots vary much in size and should be carefully graded. The best roots for planting are the size of a pencil, and 6 to 8 inches in length. It is customary to prepare the roots by making a square cut at the upper end and a slanting or oblique cut at the lower end. This will insure that the roots be planted right side up. Horse-radish roots as handled by the seed trade are usually the by-products of a commercial crop. The Bohemian or Maliner Kren variety is said to produce large, straight roots. Horse-radish is said to be a native of the Caspian and came into eastern Europe through Russia and Poland. It was in common use in Germany during the Middle Ages but was not cultivated in England until a much later period.

GROWING SEED OF SEA-KALE

Sea-kale is a hardy perennial of the Cruciferae or mustard family, native to western Europe. It is a vegetable much esteemed in Europe but little known in America. The small amount of seed used by the American seed trade is produced abroad.

Sea-kale is used for its young shoots and leaves. These are earthed up in spring or covered with a sea-kale pot until they are properly blanched. The full cutting period for a mature

bed extends over three to six weeks. If the crowns are protected with litter during the winter a bed will last over many years.

GROWING SEED OF GARDEN CRESS AND WATER CRESS

There are a number of closely related species of Garden or Upland Cress which are used in a limited way for use in salads and for garnishings. Most of these are annuals, seeds of which are sown early in spring in rows 2 feet apart, thinning the plants to stand 4 inches apart in the row. Give clean cultivation, harvest when mature, cure in the field, thresh clean and store as advised for other members of the *Cruciferae*. The Spring Cress is a biennial. Sow seed of current years' crop in midsummer or early fall. The plant will form a rosette of leaves before winter, and the following spring it will send up a flower stalk which will produce seed.

Water cress is used as an ingredient of salads. It grows in running streams of water or in moist soils, but will not thrive unless there be an ample supply of lime present. Water cress may readily be propagated from seeds or from cuttings. When once established it will persist for many years if growing conditions be favorable. Seed may be obtained from old-established beds of this plant. The amount of seed used by the trade is very small as many of the new beds are propagated from cuttings taken from nearby plantings.

GROWING SEED OF RADISH

Adaptation, uses, importance:

Radish thrives best in the cooler seasons of the year, and hence is grown largely as a spring and fall crop. It is popular with the home gardener as it is easily grown and it produces a crop in from three to six weeks from time of seed sowing. Much of the radish seed handled by the trade is used by the home gardener. Radishes are also produced by the market gardener for the nearby markets and to a limited extent by the truck farmer who ships long distances. The radish is low in

food value, but is of value in the diet as a carrier of mineral salts and it is said to be rich in Vitamin C.

In former years much of the radish seed used in America was produced in Europe. Later, large-growing centers were developed in the United States, especially in Michigan and in California. Seed equal to, and in many cases, superior to European seed is produced in these sections. During the past five years the imports from Europe have rapidly increased in volume apparently by reason of the fact that Europe can produce the crop more cheaply than can the growers in the United States.

FIG. 151.—Typical Roots of Scarlet Globe Radish. This is the most popular market garden variety. Note the symmetrical shape of the roots and the small tops and tap roots.

GROWING STOCK SEED

Choose varieties of highest quality which are best adapted to market uses. There are two types of radishes, the spring varieties which are grown as annuals for their seed crop and the winter sorts which are usually treated as biennials. Each type is made up of a large number of varieties which differ greatly in size, shape, color of root and length of time required for maturing. The spring varieties are divided as to shape into several classes, including the round- and turnip-shaped, the globe-shaped, the olive-shaped, the half-long and the long. There is a strong tendency on the part

of the seed trade to materially reduce the numbers of varieties grown.

The most popular sorts of round- and turnip-shaped radishes are, Crimson Giant, an excellent outdoor variety; Saxa, quick-growing, brilliant scarlet sort; Philadelphia White Box or White Ball, and the Sparkler strain of white-tipped scarlet turnip.

Scarlet Globe is the best of the globe-shaped varieties and is a strong favorite with the market gardener and the greenhouse grower. It quickly produces a symmetrical globe-shaped root with a vivid scarlet color. Cincinnati Market is a popular long, red radish, and Icicle is the favorite long, white variety. White Strasburg is noted for withstanding summer heat somewhat better than many of the spring varieties.

Among the better varieties of the fall and winter type are, Rose China Winter, White Chinese, California Mammoth White Winter and Half-long Black Spanish.

GROWING STOCK SEED OF SPRING VARIETIES

Select for a seed bed soil which has not recently grown a cruciferous crop, choose a rich, loose, mellow sandy loam and thoroughly. Fertilize with a 4–8–6 mixture, applying this at the rate of 400 pounds per acre.

Treat the seed with corrosive sublimate solution or other efficient disinfectant for the control of seed-borne disease. This is not a common practice with the seedsmen but if generally used it will aid in preventing loss from disease.

Plant the seed when danger of hard frosts is over. In the north this will be approximately April 20. In California, somewhat earlier. Plant in rows 12 to 14 inches apart. Keep up clean cultivation with wheel hoe.

Select for type when the roots have attained market size. Loosen the roots with a fork, pull, and sort carefully. Discard all inferior roots and those which show a tendency to quickly bolt to seed, retaining only the perfect specimens which are true

for the type of the variety. With most spring varieties a small top, and a small taproot are desirable characters. Roots which have a faded appearance or a washy color should be discarded. In order to prevent wilting of the roots they should be placed in water until ready to go to the field. Do not leave in water over night.

FIG. 152.—Degenerate Types of Radish Roots. Seed stocks will quickly become deteriorated if roots such as these are allowed to remain in the crop and produce seed.

Isolate field to prevent crossing, taking especial pains to make sure that there are no volunteer plants present. Radish when once established in a field will persist as a weed for many years unless care is taken to eradicate it. Forty rods is a comparatively safe distance between different varieties.

Choose a fertile sand or sandy loam soil and fit thoroughly. Fertilize with a complete fertilizer high in phosphorus, applying at the rate of 400 pounds per acre.

Transplant the selected roots to the field by hand or with transplanting machine, in rows $2\frac{1}{2}$ to 3 feet apart, spacing the plants 8 to 12 inches apart in the row. Pack the roots thoroughly in the soil with the bud at the surface of the ground.

Give clean cultivation throughout the growing season.—Remove weeds from row with hand hoe. Harvest when fully mature. The pods may break off somewhat in handling, but

will not open as does the pod of the cabbage. Cure in the field until thoroughly dry.

Thresh with a clean separator, specially equipped for radish. Reduce the speed of the cylinder, but maintain the necessary speed for the shakers. Use blank concaves as much as is possi-

Fig. 153.—Selecting Radish Roots for the Production of Stock Seed. The inferior roots are discarded, and the perfect roots are transplanted in isolated fields for increase. (Courtesy of Jerome B. Rice Seed Co.)

ble, to prevent splitting the seed. Clean the seed with fanning mill and if necessary spread out thinly on canvas or tight floor and stir frequently until thoroughly dry. Sack and store in cool, well-ventilated store-room. Tag each sack both inside and out with a strong tag carrying the name of the variety and the grower's name.

GROWING COMMERCIAL CROP OF RADISH SEED

Select soil as suggested for growing stock seed, fit well, and fertilize with complete fertilizer high in phosphorus. Be certain that the field contains no volunteer radish plants.

Plant the stock seed thinly in rows 2½ to 3 feet apart, according to habit of growth of the variety, using 2 to 3 pounds per acre. Plant the seed when all danger of hard frosts are over.

Isolate the fields to prevent crossing.—Do not plant a radish crop for seed in fields which have previously grown radishes at any time during the preceding five years.

Give clean cultivation during the growing season and remove weeds from row with hand hoe.

Harvest the crop when fully mature, using mowing machine. Remove the plants from behind the mower so that the seed pods may not be lost through trampling of the horses.

Cure in field, thresh, clean, dry, sack and store the seed in the same manner as for stock seed.

GROWING SEED OF WINTER VARIETIES

Select clean soil as for stock seed and fertilize as previously described.—Plant the seed in late summer in the manner advised for stock seed. Remove the roots from the field before damaged by freezing, and store over winter in soil as recommended for beets. Select the roots carefully before pitting, retaining only perfect roots that are true to type of the variety.

Transplant the roots to field in early spring, spacing them in rows 3 feet apart, allowing 10 to 12 inches between the roots in the row.

Exercise the same care in selection of soil, isolation of field, in fertilizing and cultivating the crop as for spring varieties.

Harvest the crop when fully mature, cure, thresh, clean and store as described for spring varieties.

GENERAL INFORMATION

History and botanical discussion.—The radish is considered to be a native of Europe and Asia. Many of the winter varieties doubtless originated in China and Japan. Radishes were highly esteemed by the early Egyptians at the time of the Pharaohs, and were also known to the ancient Greeks. The radish belongs to the *Cruciferae* and is related to cabbage, cauliflower, and other members of this family. It does not belong to the same genus and rarely, if ever, makes crosses with them.

Diseases and insects:

Radishes may be attacked by a number of diseases of the cabbage family. The same methods of control, seed disinfection and crop rotation are advised as for cabbage.

The insects which are most likely to cause injury to the radish crop are the plant lice or aphids, the cabbage root-maggot and the flea-beetle. Corrosive sublimate solution, applied along the row, will aid in keeping the root-maggot under control. This remedy is more practicable for the market crop and the home garden, as it is seldom that the maggot seriously reduces the seed crop. Dusting with a 2 to 3 per cent nicotine dust will help to keep down the aphids, but this measure of control must be started as soon as the aphids appear, as they increase in numbers very rapidly and may often destroy a crop in a very short time. The flea-beetle is not easily controlled on the radish, but it is seldom present in large enough numbers to do much damage.

Cut-worms and grasshoppers may sometimes prove to be serious pests. A persistent use of poisoned baits will aid greatly in the control of these pests.

It is unfortunately true that many of the farmers in the radish-growing sections of America are somewhat lax in methods of cultivation and it is quite often the case that the crops are allowed to become weedy. The seeds of certain of the common

weeds prevalent in these localities, especially those of the wild buckwheat, are difficult to remove from radish seed. In order to make the seed merchantable, the seedsman is often compelled to go to considerable expense to dispose of these weed seeds. Special machinery is required to clean the seed. The careful grower would certainly realize a greater profit in increased yield and in greater price per pound if he would take more pains to remove the weeds from the growing crop.

CHAPTER XVI

GROWING SEED OF SOLONACEOUS VEGETABLES: TOMATO, PEPPER, EGG PLANT, HUSK TOMATO OR GROUND CHERRY, WONDERBERRY, TOBACCO

GROWING TOMATO SEED

The tomato may be grown over a wide range of territory. It is one of the most popular vegetables, and there is perhaps no other vegetable which has so many uses or which may be

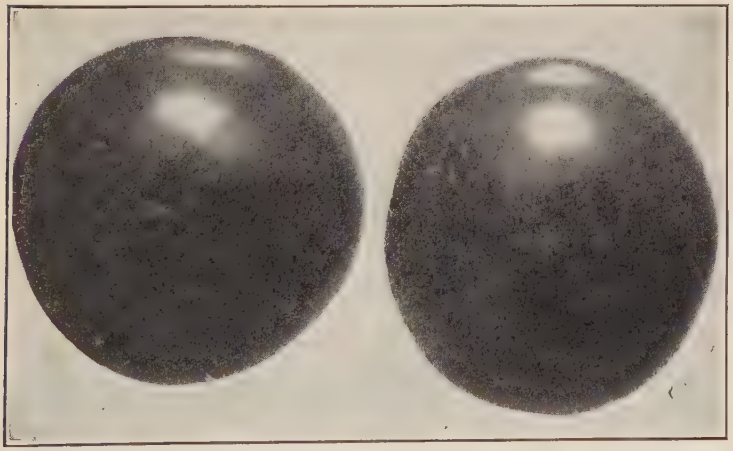

FIG. 154.—John Baer Tomato. An early, smooth and productive variety, much favored by the market gardener.

served in such a variety of ways. The tomato is grown in nearly every home garden, by many market gardeners, as an important crop for the southern truck farmer, and it also takes first place in the list of canner vegetables.

Operations:

Choose varieties of highest yield and best quality.—At the present time few, if any other, vegetables occupy so greatly the attention of the plant breeder. New varieties and improved strains of old varieties are added each year in considerable numbers to the seedsmen's lists. Strains of variety may differ greatly as they may have been selected and developed by different plant breeders. In recent years much work has been accomplished by plant breeders in selecting and developing strains which are resistant to certain diseases.

The market gardener selects an early, smooth, productive variety and strain, while the canner is not so much interested in earliness but rather he desires productiveness first, combined with good color, smoothness, solid flesh, and freedom from core.

Among the better market garden varieties in use at the present time are:

Red:
John Baer,
Earliana,
Bonny Best,
Marvel (Wilt Resistant),

Pink:
June Pink,
Globe,
Early Detroit.

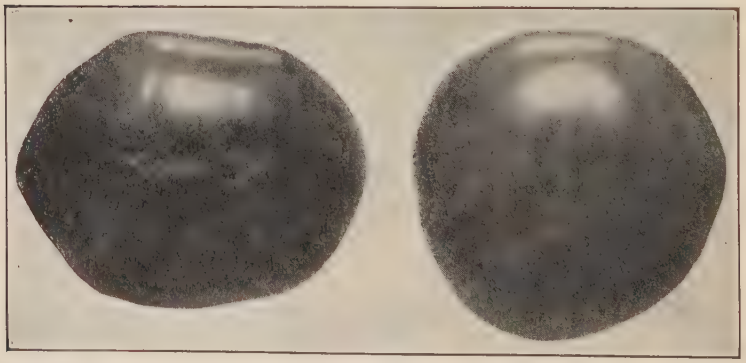

FIG. 155.—Greater Baltimore Tomato. The fruit at the left is off-type in shape, having a large scar or "cat face." Plants producing fruits of this type should be avoided when making stock-seed selections.

The more important canner varieties are:

Greater Baltimore,
Stone,
Norton (Wilt Resistant),
John Baer and Bonny Best for northern states,
Marglobe (Wilt Resistant).

FIG. 156.—Smooth Ground Cherry, a Common Weed which is often a Carrier of Mosaic Disease. Destroy these weeds where found near tomato plant bed or field.

Sterilize soil in the seed bed.—A number of serious diseases of the tomato are soil-borne and, if present in the soil, may infect the tender seedlings. Use steam, or hot-water treatment, if proper facilities are at hand. If not, a solution of formalin may be used, although this will not destroy nematodes. If the soil is clean and has not previously grown tomatoes or a related crop. it may not be necessary to sterilize.

Grow good strong plants.—Much of the success of the crop depends upon the manner in which the plants were grown. So time the planting of the seed that when the proper time for planting in the field arrives, the plants may not be overgrown and woody nor yet too young and tender. A steady continuous growth, with no check at any time, is necessary for proper development of the best type of plant. Harden the plant before transplanting to the field so that it may properly withstand the shock of transplanting. Do not crowd the plants in the seed bed so that they are compelled to grow tall and slender.

Spray the plants in the cold frames with 2–4–50 Bordeaux Mixture. This will take but little time and expense and will greatly aid in keeping Septoria and other serious diseases in check.

Isolate fields to prevent crossing.—While the tomato does not readily cross, if two varieties are planted closely together there is likely to be a certain amount of cross-pollination which may impair the value of a strain. A few rods between varieties will ordinarily be safe.

Select clean fertile clay loam or silt loam soil and fit thoroughly. Fertilize with a complete fertilizer which contains a high percentage of phosphorus. Apply 300 to 500 pounds per acre broadcast and work thoroughly into the soil.

Transplant the plants to the field when all danger of frost is over and the soil is warm. Plant the dwarf varieties 3 by 3 feet and the standard, tall-growing sorts at least 3 by 4 feet.

Give frequent shallow cultivation at intervals of a week or ten days until the vines become so large that they interfere with cultivation. As a rule the more thorough the cultivation the greater will be the crop produced.

Spray in field with 4–4–50 Bordeaux Mixture at intervals of two weeks, if necessary, for the control of Septoria leaf spot. Use a power sprayer with a heavy pressure and so arrange the nozzles that the entire surface of the leaves may be coated with the spray.

Rogue the crop and remove any plant which may be badly

diseased or not true to the type of the variety. A single off-type plant may produce many thousand seeds and thereby cause a bad mixture in succeeding generations.

Make first picking for seed when $\frac{1}{3}$ to $\frac{1}{2}$ of the crop is ripe. Use only sound, well-matured fruits, rejecting any which may appear to be diseased. Make the second and later pickings when necessary to prevent decay of fruit.

Thresh with pulping machine similar to that used for cucumbers and melons. The essential points of such a machine are first, a set of corrugated or toothed rolls set closely together so as to crush the fruit; and second, a revolving wire-meshed cylinder which removes the coarse parts of the pulp and allows the seed and juice to drop through into a tight receptacle.

Ferment the seed in casks or vats until the sack of pulp with which each seed is covered, breaks down so that the seed may be readily washed clean. Stir frequently while fermenting so that the seeds at the top may not become discolored. Do not let the fermentation proceed longer than is necessary or the vitality may become impaired. Allow no rain or other water to enter the fermenting vats as a small amount of water may cause many seeds to sprout. As fermentation takes place, much of the seed and pulp will become charged with gas and will rise to the top of the vat. The detached heavy seed will sink to the bottom leaving a stratum of clear juice between. This may be tapped and drawn off in the field, thereby reducing the amount of material to be carted to the washing place.

Wash the seed clean, freeing it from all pulp and refuse. This may be accomplished by one of two methods. The gravity method is based upon the fact that clean tomato seed is slightly heavier than water while the pulp is lighter. A long narrow box with cross-partitions at intervals of 2 feet is placed in a sloping position near the water supply. A constant, slow stream of water is allowed to flow through this box or trough. The tomato seed and pulp is poured into the trough at the higher end. The pulp will float off and the seed will sink and be caught behind the partitions.

Another method, one used by some of the largest growers, allows the seed to be washed very rapidly. An oblong angle-iron frame measuring about 5 by $2\frac{1}{2}$ feet is constructed, which rests upon and is hinged to four upright legs about 20 inches long. These legs are hinged in boxes at the bottom. This frame is connected at one end to a short-drive shaft by two arms which are each attached to eccentric wheels on either end of the shaft. A pulley is carried at the center of the drive-shaft and this is connected with some source of power. As the drive-shaft revolves the angle-iron frame is given a rapid shaking movement. An oblong box is constructed of 1 by 12-inch material of a size which will allow it to fit snugly in the angle-iron frame. The bottom of this box is covered with a fine screen which will retain the seed but will allow the fine pulp to pass through. This screen bottom is protected and reinforced by an outer covering of heavy wire mesh. Cleats on the inside of this box support a smaller box which fits closely inside. This box is constructed of 1 by 6-inch material and is covered at the bottom by a coarser screen which will allow the seed to pass through, but which retains the coarse pulp. Such a machine requires two men to operate. The shaker is set in motion and one man shovels in pulp and seed while the other rapidly dashes water into the screen with a pail. This is continued until about 15 to 20 pounds of clean seed are in the sieve. More water is added and the shaking motion is continued until the water below runs clear. The smaller sieve is removed and the contents of stems, skins, and coarse pulp is dumped. The clean seed is shoveled out into barrels. These barrels have 1-inch holes bored in the bottom, which are covered with screen. This is to allow for drainage of excess water. The machine, which has just been described, if fitted with proper size mesh, may be used to wash a variety of seeds such as cucumber, melon, squash, and pumpkin.

Dry the seed by spreading thinly on cloth-covered frames exposed to the sunlight or by some form of artificial heat as for cucumbers. When large quantities of tomato seed are handled,

it is of advantage to remove as much of the excess water as is possible by centrifugal action. The wet seed is placed in coarse-meshed sacks which are enclosed in a centrifugal machine and revolved at a high rate of speed. A machine such as is used by the laundry man for drying clothes is very efficient for drying seeds.

A considerable portion of the tomato seed used by the canner

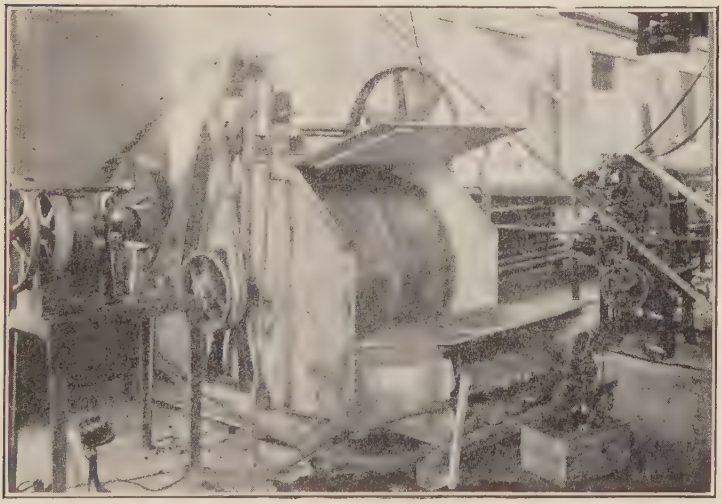

Fig. 157.—Apparatus for Drying Tomato and Other Small Seeds. The seed is placed in the revolving screen cylinder, the folding doors are closed, and a current of warm air is blown through the seed by the fan. (Courtesy of J. C. Allen.)

is saved at the canning factory. The washed tomatoes are run through a " cyclone " which removes practically all of the pulp, hence, there is no need for fermentation. The seed is removed from the " cyclone," screened to remove skins, stems, etc., rinsed and dried. Much of the pubescence or hairy coating of the seed may be removed by this process, but the vitality seems to be little impaired.

Clean the seed through fanning mill and store in sacks in a cool, well-ventilated storeroom.

Maintain breeding and increase plots.—There are few vegetables which will respond so quickly to selection. Select a number of plants of an ideal type for the purpose in view, save the seeds of each plant separately. Plant a small test plot from each selected lot and plant the seed of the best lot for further increase. An improved strain may rapidly be built up in this manner.

GENERAL INFORMATION

History and botanical description:

The tomato is a native of South America. While, without doubt, it was used by the natives as an article of diet long before the discovery of America, for some reason it was believed by the Europeans to be highly poisonous, and while it was grown in the garden as an ornamental plant under the name "love apple," it did not come into general culinary use for many years.

The tomato belongs to the *Solonaceae* or night-shade family and is closely related to the potato, pepper, and egg plant. Its popularity as an article of diet has rapidly increased within recent years due to the discovery that its fruits are not only rich in valuable mineral salts, but also contain a high vitamin content.

Diseases and insects:

The more important diseases of the tomato are: fusarium wilt, bacterial wilt, leaf spot, early blight, late blight, and blossom-end rot.

Fusarium wilt is a serious disease over a large section of the United States where temperature conditions favor its development. The leaves roll upward, turn yellow and finally die. A cross-section of an infected stem shows a brown discoloration between the pith and the bark. The disease organism lives in the soil for several years. Crop rotation and the use of wilt-resistant varieties are the only means of control.

Bacterial wilt is a serious disease in the South. The infected plants wilt rapidly and die. A cross-section of an infected stem will show a black discoloration and the cut stem exudes a slimy juice. The bacteria which cause the disease are probably carried by insects. The control remedies suggested are: sterilization of soil in seed bed, a long crop rotation so that tomatoes

FIG. 158.—Tomatoes Growing on Soil Infested with Fusarium Wilt. The non-resistant check row at the right-center has been nearly destroyed by disease, while the resistant strain of Century tomatoes at the left is strong and vigorous. (Courtesy of Prof. Walter Huelson of the Illinois Agricultural Exp. Sta.)

or related crops will not be planted in the same soil more than once in several years, removal of the infested plants from the field as soon as discovered, keeping in check all insects which may carry the disease, and using care to prevent injury to plant or roots when transplanting or cultivating.

Leaf spot.—This disease, also called leaf blight, is perhaps the worst disease which infects the tomato. The leaves develop

water-soaked spots which later turn brown. The entire leaf eventually dies and drops off. The leaf spot usually starts at the bottom of the plant and works up along the stem, killing the leaves as it goes. Control measures consist in sterilizing the soil in the seed bed, spraying the seedling plants with 2–4–50 Bordeaux Mixture before removing from cold frames rotation of crops, and spraying in field with 4–4–50 Bordeaux Mixture.

Early blight.—The lesions caused on the plant much resemble those caused by leaf spot. In some cases the fruits also show diseased spots. Control measures as recommended for leaf spot will hold this disease in check.

Late blight is caused by the same fungus which causes late blight of potatoes. The disease may appear late in the season. It may cause a spotting of the leaves, a rotting of the stems, and in severe cases, the death of the plant. On the fruit, a sunken discolored spot may appear at the stem end. Spray with 4–4–50 Bordeaux Mixture to check this disease.

Blossom-end rot causes a sunken discolored spot on the blossom end of the fruit. No causal organism has yet been found and it is generally believed that this is a physiological disease due to some unfavorable condition of moisture or temperature. Good cultural methods will aid in control of this disease.

Mosaic.—A tomato plant affected with Mosaic disease shows a mottling of the leaf and an abnormal leaf development, the younger branches often bearing leaves which appear to be fernlike in shape. Mosaic disease may spread rapidly and seriously reduce production of crop. It infects a number of closely related plants and is spread largely by insects. Control measures suggested are: do not use plants from a bed in which Mosaic is present, eradicate all horse nettles and ground cherries near plant beds, keep the fields free from all solonaceous weeds, keep plant beds clean during summer months and control insects which may carry the disease.

Tomato hornworm.—This large green worm, with whose

appearance every one is familiar, may be destroyed by hand picking or by spraying the plants with arsenate of lead.

The tomato fruitworm, sometimes called the cotton boll worm, and in the North, the corn ear worm, may sometimes

FIG. 159.—Mosaic Infected Tomato Leaf at the Left; healthy Leaf at Right. The small fern-like appearance of the leaf and the distortion and mottling of the leaflets are typical of the tomato mosaic disease. (Courtesy of Dr. M. W. Gardner of the Purdue Univ. Exp. Sta.)

cause serious damage and loss, especially in the more southern sections. Sweet corn planted in the vicinity of a tomato field will act as a trap plant. Spraying the tomato plants with arsenate of lead will aid in controlling this pest.

GROWING SEED OF PEPPERS

Peppers thrive best in a warm climate and in certain sections of the South they are grown in large quantities for canning. The pepper is also grown extensively as a southern trucking crop, as a market garden crop in the North, and in many home gardens. It is used in a number of ways, in sauces and condiments, in salads, and the larger fruits may be stuffed and baked.

Choose varieties of highest yield, best quality and that are adapted to the use of the gardener and canner. There are two classes of peppers, the "hot" and the sweet. The popular hot varieties are Tabasco, Long Red Cayenne, Red Chili, Red Cluster, and Cherry. Of the large-fruited sweet varieties. Chinese Giant, Ruby King, Large Bell or Bullnose, Early Giant, Giant Crimson, Golden Queen, and Sweet Mountain are among the best. The canner used a long season thick-meated pepper called Pimento. This is conical in shape and is very mild.

FIG. 160.—A Typical Fruit of Ruby King Pepper.

Sterilize soil in seed bed in order to prevent infection of young seedlings with soil-borne diseases. Disinfect seed with solution of corrosive sublimate, soaking the seed for ten minutes and afterward rinsing in clean water. Sow the seed early in greenhouse or hot beds. Spray the plants in the seed bed with 4–4–50 Bordeaux Mixture to aid in the control of disease.

Isolate fields to prevent crosses.—The pepper, like the tomato, does not usually cross to a large degree with other varieties growing nearby, but a certain percentage of crossing will take place if two sorts are growing in close proximity, hence there should be an interval of several rods between two varieties growing for seed purposes.

Select a fertile, warm, well-drained sand or sandy loam soil.—Plow early and fit thoroughly. Apply 300 to 500 pounds per acre of a complete fertilizer high in phosphorus, broadcast this is on the plowed surface and work thoroughly into the soil.

Transplant the plants to the field when the soil is warm and all danger of frost is over. Transplant the plants in rows $2\frac{1}{2}$ to 3 feet apart, spacing the plants 18 inches apart in the row.

Give frequent and shallow cultivation.—Hand hoe, if necessary, to remove weeds from the row.

Rogue the fields to remove diseased or off-type plants. Varieties vary much as to height and habit of growth. A rogue in a crop of peppers may often be distinguished before the fruits develop.

Harvest when fully mature.—Thresh with machine similar to that used for cucumbers. The crushing rolls should be so arranged as to macerate the fruits and loosen the seeds from the core. Certain seedsmen shovel the fruits into the hopper of an ordinary corn sheller which grinds them in a satisfactory manner. Wash the seed immediately without fermenting, using a current box equipped with a screen which will allow the seed to fall through, or with the shaker washer as advised for tomatoes. Spread thinly on cloth-covered frames to dry or use artificial heat as recommended for tomatoes.

Clean with fanning mill, place in clean bags and store in a cool, well-ventilated storeroom.

Maintain breeding and increase plots.—Make field selections of superior plants and save the seed of each separately. Plant in isolated plots and reserve the progeny of the best plant for further increase.

GENERAL INFORMATION

History and botanical discussion.—It is believed that the pepper is a native of South America. It was early introduced into Europe and came quickly into common use. It belongs to the *Solonaceae* or night-shade family, hence, is related to the tomato and potato. Pepper varieties may intercross, but it is not likely that they cross with the tomato or potato. The cultivated varieties are considered to belong to one species; *Capsicum annuum.*

Diseases and insects:

The diseases which affect peppers include anthracnose or rot, leaf spot, and Mosaic. These diseases are not likely to seriously injure the crop. Sterilizing soil in the seed bed, disinfecting the seed and treating the seedling plants with Bordeaux Mixture are among the recommended control measures for anthracnose and leaf spot. For Mosaic, the same method of control as for tomatoes should hold the disease in check.

The pepper plant is seldom injured to a great extent by insect pests, although it may be attacked by potato beetle, flea beetle, potato aphis, and spinach aphis. Control measures as recommended for these insects may be used.

GROWING SEED OF EGG PLANT

The egg plant is a crop of minor importance. It is grown as a trucking crop in the South, to a small extent by the market gardeners of the central and northern states, and occasionally in the home garden. This vegetable thrives best during a long, hot-growing season, and cannot often be successfully produced in certain sections of the North.

Choose varieties of best quality and market adaptation.—The varieties more largely in use are New York Improved and Black Beauty.

Sterilize soil in seed bed and disinfect the seed with corrosive sublimate solution, afterward rinsing thoroughly for

fifteen minutes in running water. Sow the seed early in greenhouse or hot bed so that plants will be large and well-developed when ready for the field. Isolate the fields to prevent crossing.

Select a warm, well-drained sand or sandy loam, plow early and fit thoroughly. Fertilize with high-grade complete fertilizer, using 500 to 1000 pounds per acre.

Transplant the plants to the field when the soil is warm and all danger from frost is over. Space the plants 2 to 3 feet apart in rows 3 to 4 feet apart. Give frequent shallow cultivation.

Harvest the fruits when fully mature as may be indicated by the changing color of the ripe "egg." Thresh the seed by crushing the fruits with a specially equipped machine which macerates the pulp. Wash at once without fermenting, with sieve and current box or with shaker washer as recommended for tomato. Spread seed thinly on cloth-covered frames and dry as quickly as is possible to prevent discoloration of the seed. When seeds are thoroughly dry, clean with fanning mill and store in sacks in a cool, well-ventilated storeroom.

GENERAL INFORMATION

History and botanical discussion.—The egg plant is believed to be a native of India and has long been in cultivation. It belongs to the *Solonaceae* or night-shade family. There are a number of dwarf forms which require a relatively short season for development. These are sometimes grown for the home garden but have no commercial importance.

Diseases and insects.—The principal diseases which affect the eggplant are the wilt, bacterial wilt, and fruit rot. Crop rotation, seed disinfection, and seed-bed soil sterilization should hold these diseases in check.

Egg plant flea beetle is a serious pest, especially when the plants are small. Dip the plants in 3–3–50 Bordeaux Mixture at time of transplanting and ten days later spray with 4–4–50 Bordeaux mixture to which has been added 4 pounds arsenate of lead paste to each 50 gallons of water.

Colorado potato beetle may sometimes cause serious injury. Spray as for potatoes.

Egg plant lace-bug, a sucking insect, may be held in check by the use of a spray of nicotine sulphate solution. Use 8 ounces of nicotine sulphate to 50 gallons of water.

Egg plant tortoise beetle may sometimes cause injury by eating holes in the leaves. Spray the infested plants, using 1 pound arsenate of lead powder to 50 gallons of water.

GROWING SEED OF HUSK TOMATO OR GROUND CHERRY

The husk tomato is a vegetable of small importance. This vegetable is not grown commercially but is cultivated to a small extent in home gardens. The fruits are used mainly for preserves. Its general cultural requirements as to soil, and manner of handling the plants, are similar to that of tomatoes. The plants are much smaller and may be spaced 2 feet apart in rows 3 feet apart. The fruit is small and round and is produced inside of a husk composed of an enlarged calyx tube. When fully matured, the fruits are crushed and the seed washed, dried, and cleaned much in the same manner as for tomato.

The husk tomato is a member of the family *Solonaceae* or night-shade family and is closely related to the wild ground cherry and the horse nettle.

Another member of the family *Solonaceae* is used to a very very small extent in the home garden under the name Wonderberry, or garden huckleberry. This is in no way related to the true huckleberry but is a cultivated form of the black nightshade. The fruits are insipid in flavor but are sometimes used for making pies and preserves. They should not be gathered for use until fully ripened as the green fruits are quite likely to be more or less poisonous.

The methods of care and culture for the production of seed are similar in many respects to those recommended for ground cherry.

TOBACCO SEED

(By Prof. E. J. Kinney, University of Kentucky)

About 1,700,000 acres of tobacco are grown in this country and the average value of the crop is somewhat over $350,000,000. This value is exceeded only by that of corn, hay and forage, cotton, wheat, oats and potatoes. Yet 15,000 to 20,000 pounds of seed is probably sufficient to provide for the entire acreage and this amount of seed can be easily produced on 100 acres of land. The farmer who raises 15 to 20 acres of tobacco, a rather large crop, gets an abundance of seed from the half-dozen choice plants he saves for seed and probably has some left for his neighbor who forgot to save seed. It is only in rather recent years that anyone bought tobacco seed—they either saved it or "borrowed" from neighbors. It is easy to see, therefore, that the commercial tobacco seed business is not of great importance and certainly not worthy of being called an industry. During the last fifteen or twenty years, however, an increasing number of farmers have been buying seed. This has come about largely through development of strains of tobacco of outstanding excellence and which have become widely popular. As a result there has been a heavy demand for seeds of these varieties and the originators have found it very profitable to produce seed for sale. The cost of seed for even a large crop of tobacco is so small that growers are willing to buy seed they know will give good results rather than to go to the trouble of saving their own seed. Consequently a rather large trade has developed, especially in the white burley regions.

In producing high-grade seed, the important point is to select good parent plants. The seed grower goes over his field very carefully and picks out a dozen or more plants that show uniformity and high quality. The seed heads are bagged to prevent mixing with inferior plants and the seed from these elite plants is used for raising the next year's seed crop.

The seed crop is handled like any ordinary crop of tobacco but only the inferior plants are topped. After a good crop of

pods have set the other blossoms are kept pinched off. When the pods begin to turn brown the seed heads are cut off and dried under shelter. In many cases the plants are then harvested and may make a fair crop of leaf. The seeds are beaten out by hand and carefully cleaned and graded. They are usually sold in packets containing an ounce or a half-ounce of seed. The usual price is $1.50 per ounce. An ounce will produce enough plants to set 10 acres of tobacco. The yield depends upon what percentage of the plants are suitable for seed. Perhaps 200 pounds of seed per acre is an average yield.

CHAPTER XVII

GROWING SEED OF GARDEN AND CANNING BEANS AND PEAS

GARDEN BEANS, INCLUDING LIMA BEANS

The varieties of garden or kidney beans exhibit a wide variation in type, habit of growth, climatic adaptations and uses. Among the contrasting types there are: dwarf varieties and pole varieties, wax-pod and green-pod sorts, flat-pod and round-pod types. In certain varieties the pods contain much string and fiber, while in others the pods are practically stringless.

The dwarf varieties constitute by far the most important group. They require a relatively short season in which to mature a crop, and they may be grown with little expense. The pole varieties, as a rule, require a long season for development, and the expense of growing a crop is often much greater than with the dwarf varieties.

A large proportion of the crop of the garden bean is used in the form of "snap" beans, a relatively small amount is used for green-shelled beans, and a still smaller proportion is used in the dry state for baking.

Among the varieties of lima beans there are the contrasting types: dwarf and pole varieties, flat-seed and thick-seed or the so-called "potato type," also large-seed and small-seed sorts. The various varieties of lima beans are used either as green-shelled beans or, when cured and dry, for baking.

Choose clean seed of adapted varieties of highest yield and best quality.—A number of serious bean diseases are known to

be carried in the seed, hence, it is highly important to secure foundation seed stock that is free from disease.

High quality in the green snap bean is an important consideration to the gardener as well as to the canner. There is no distinct line drawn between garden types and canner types. A number of plant breeders are attempting to secure new varie-

Fig. 161.—A Clean Field of Refugee Wax Seed Beans in Michigan.

ties which are resistant to disease. It is quite likely that in the near future some of these new varieties will supersede certain of our standard sorts of to-day.

The following table includes a large number of the better varieties in present use:

Isolate fields to prevent crossing.—While the bean belongs to the group of plants which are normally self-pollinated, under certain circumstances two varieties planted near each other

List of Certain of the Better Garden and Canner Beans

Variety	Habit of growth	Color of Pod	Shape of pod	Use	Adaptation
Pencil Pod Black Wax	Dwarf	Wax	Round	Snap	Gardener
Golden Wax	Dwarf	Wax	Flat	Snap, cut pods	Gardener and Canner
New Kidney Wax	Dwarf	Wax	Flat	Snap, cut pods	Gardener and Canner
Refugee Wax	Dwarf	Wax	Round, small,	Can whole pod	Canner
Round Pod Kidney Wax	Dwarf	Wax	Round	Snap, cut pod	Gardener and Canner
Sure Crop Wax	Dwarf	Wax	Flat	Snap	Gardener
Webber Wax	Dwarf	Wax	Flat	Snap	Gardener
Bountiful	Dwarf	Green	Flat	Snap, cut pod	Gardener and Canner
Stringless Green Pod	Dwarf	Green	Round	Snap, cut pod	Gardener and Canner
French's Horticultural	Dwarf	Green	Round	Shell bean	Gardener
Full Measure	Dwarf	Green	Round	Snap, cut pod	Gardener and Canner
Giant Stringless	Dwarf	Green	Round	Snap, cut	Gardener and Canner
Horticultural Dwarf	Dwarf	Green	Flat	Shell bean	Gardener
Low's Champion	Dwarf	Green	Flat	Cut bean and shell bean	Gardener and Canner
Red Kidney	Dwarf	Green	Flat	Shell bean	Baked and canned when mature
Refugee Stringless	Dwarf	Green	Round	Snap	Canner and Gardener
Burger's Green Pod	Pole	Green	Round	Snap	Gardener
Golden Cluster Wax	Pole	Wax	Flat	Snap	Gardener
Kentucky Wonder	Pole	Green	Round	Snap	Gardener
Hampden Pole	Pole	Green	Flat	Shell bean	Gardener
Burpee Improved Bush Lima	Dwarf			Shell bean	Gardener
Fordhook Bush Lima	Dwarf			Shell bean	Gardener "Potato Lima"
Henderson Bush Lima	Dwarf			Shell bean	Canner and Gardener
Carpinteria Lima	Pole			Shell bean	Gardener
Dreer's Improved Lima	Pole			Shell bean	Gardener "Potato Lima"
Early Leviathan Lima	Pole			Shell bean	Gardener
Large White Lima	Pole			Shell bean	Gardener
Siebert's Early Lima	Pole			Shell bean	Gardener

may intercross to a considerable degree. It is better to run no risk of crossing by separating varieties in the field at a distance of at least 40 rods. Lima beans belong to a different species from the kidney beans and will seldom, if ever, make crosses with them.

Select a clean fertile loam soil for the bean crop, soil that is not only free from weeds, but which has not grown beans during the preceding season. Plow early and fit thoroughly. Much labor may be saved in cultivation if soil is properly fitted before seed is sown.

Fertilize with a complete fertilizer high in phosphorus.— This may be applied broadcast on the plowed surface and thoroughly worked into the soil, or if the beans are sown with a grain drill, the fertilizer may be applied at the same time. Care should be taken that not more than 75 pounds per acre be applied directly in the rows with the seed, as a greater amount might cause injury.

Plant the seed when all danger of frost is over and the ground is warm, in drills 28 to 36 inches apart, using an ordinary grain drill with all but three of the runs closed, a two-row corn drill fitted with proper rings, or one of the special bean drills which are now manufactured for this purpose. As the size of seed in the different dwarf varieties varies greatly, use 45 pounds per acre for small seed varieties, and 60 pounds for the larger seeded sorts. The pole varieties are sown at the rate of 30 pounds per acre.

Give clean cultivation, starting when the beans first appear above the ground. Do not cultivate when plants are damp with dew or rain, for if there be present a small amount of disease, this is a certain means of spreading the disease throughout the entire crop. Avoid deep cultivation in order to prevent injury to the feeding roots which lie close to the surface, particularly when the plant has attained a considerable size.

Rogue the fields thoroughly in order to remove all diseased plants and off-types. In crops from the best of seed stocks there is likely to be a number of plants which do not conform

to the type of the variety. These are generally easy to distinguish. Among the characters to be observed are the blossom, habit of growth and the pods. A plant with a purple blossom, among plants which normally produce white blossoms, indi-

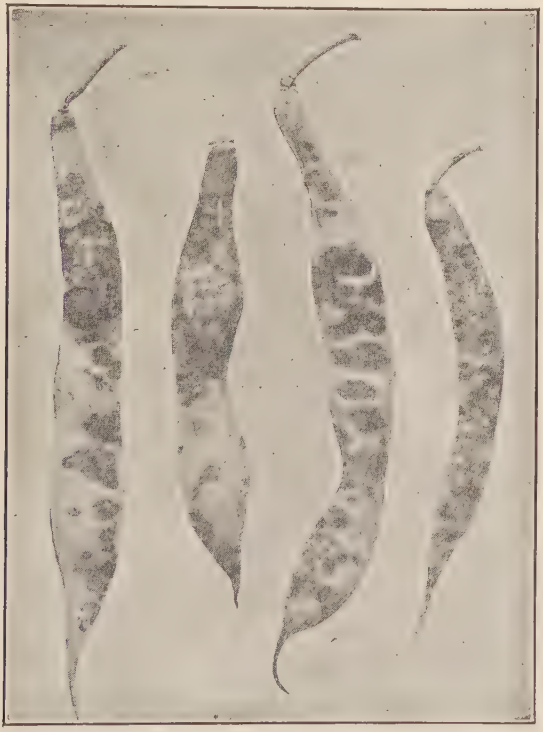

Fig. 162.—Bacterial Blight of the Bean. Seed from diseased plants will carry the disease to the next generation. Plant clean seed to avoid disease. (Courtesy Dr. M. W. Gardner, Purdue Agri. Exp. Sta.)

cates an off-type. A plant with runners growing in a field of normally dwarf plants is out of place. Rogue out the flat-podded plants from crops which are normally round podded and vice versa, green-podded plants from crops which are

wax podded, stringy-podded plants from crops which should contain no stringy pods. An expert field man may soon learn to distinguish a stringy pod from a stringless one by the appearance of the pointed tip which, in the stringy pod, is sharp and hard and, in the stringless pod, is blunt and more soft in appearance. A short-forked stick carried in the hand will enable the grower to turn up the leaves and examine the plants without difficulty.

Harvest when properly matured.—If allowed to become overripe, many pods may shatter in the field and be lost. Use a two-row bean puller for dwarf varieties. Fork the beans free from soil immediately after pulling. This operation may be done by hand, or under favorable conditions, with a side-delivery rake.

Cure the crop in the field.—In the more arid regions, or in a dry season, the beans may be forked in small piles or cured in the windrow. Where rain is to be expected, it is safer to stack the plants in small stacks around poles driven in the field. When well cured, store in mow or in well-covered stacks.

Thresh the crop with a bean separator equipped with proper screens. Adjust the speed of the cylinder so that there will be clean separations, and at the same time little, if any, splitting of the beans. Clean the crop as well as possible with fanning mill, hand pick to remove stained or discolored seed, and store in sacks in a cool, well-ventilated storeroom.

Treat the stored seed with carbon disulphide if there be any indication of infestation with the bean weevil. Beans infested with weevil should not be used for seed since the weevil carries over. Early fumigation will prevent breeding and increase of the weevil in the storehouse.

Maintain breeding and increase plots.—There is much room for improvement through selection in even the best of the standard varieties. Select, each year, a number of plants which show vigor, productiveness, freedom from disease, and other desirable characters. The following year, plant the seed from each plant separately, and save for future increase the progenies

which are more nearly ideal. It is quite possible to produce improved strains in large quantities within a very few generations as the increase is very rapid. The bean crop offers great opprtunity to the plant breeder as it is normally self-fertile and, hence, it is easy to work with.

GENERAL INFORMATION

The kidney bean is considered to be a native of South America. It was cultivated by the American Indians as one of their staple food crops. Many different varieties were found at the time of the discovery of America by Columbus, indicating that this plant had long been under cultivation.

It belongs to the family *Leguminosae*, which includes a large number of our economic crops such as clover, alfalfa, and peas, to which it is closely related. It belongs to the same species as our common field varieties and, hence, it is subject to the same insects and diseases which we have discussed in a previous chapter.

The lima bean is also a native of tropical America and wild forms may be found to-day. It was also grown by the American Indians, but as it required a long season for development and was partial to a warmer section than the kidney bean, it did not become as widely distributed. It is not subject to many plant diseases and with care in selecting clean seed stock it may be kept relatively free from disease.

GROWING SEED OF GARDEN AND CANNING PEAS

The pea is one of the most important garden plants of the United States. It is found in nearly every home garden, is widely grown by the market gardener, and as a canned product it ranks third in tonnage, being exceeded only by sweet corn and tomatoes.

There is no other seed crop grown in which the ratio between the product of an acre grown for seed and that required to plant an acre of crop is so small. The canner usually sows from 3 to

FIG. 163.—Seed Peas are Produced in Northern Regions of Comparatively Cool Growing Seasons. Idaho, Montana and Washington lead in production. (Courtesy Seed World.)

4 bushels of seed per acre, and hence, an average acre grown for seed will produce seed for but 3 acres of canning peas. In 1925, there were more than 100,000 acres devoted to the production of seed peas, more than one-half of which was used by the canning trade.

FIG. 164.—Typical Pod of Alaska Pea. This variety is the most important of the canner sorts.

The market gardener sows a wide list of varieties as he may find them adapted to his conditions. The canner confines himself to a very few varieties which he has found to be satisfactory for his needs.

Choose adapted varieties of highest yield and best quality. — There are

List of Leading Garden and Canner Pea Varieties

Variety	Height	Seed	Season	Quality	Pod	Adaptation
Acquisition	2½ ft.	Smooth	Early	Fair	Large, pointed	Market Garden
Advancer	2¼ ft.	Wrinkled	Mid-season	Good	Small, blunt	Canner, Sweet
Admiral	3½ ft.	Wrinkled	Mid-season	Good	Small, blunt	Important Canner variety
Alaska	2½ ft.	Smooth	Early	Fair	Small, blunt	Leading Canner variety
Alderman	3½ ft.	Wrinkled	Late	Good	Large, pointed	Home and Market Garden
Ameer	3 ft.	Smooth	Early	Fair	Medium, pointed	Market Garden
Bountiful	3 ft.	Smooth	Early	Fair	Medium, pointed	Market Garden
Canner's Perfection	2½ ft.	Wrinkled	Mid-season	Good	Small, blunt	Canner Sweet variety
Champion of England	4 ft.	Wrinkled	Late	Good	Small, blunt	Home and Market Garden
Dwarf Defiance	2 ft.	Wrinkled	Mid-season	Good	Large, pointed	Home and Market Garden
Dwarf Telephone	2½ ft.	Wrinkled	Mid-season	Good	Large, pointed	Home and Market Garden
Duke of Albany	3½ ft.	Wrinkled	Late	Good	Large, pointed	Home and Market Garden
Extra Early	2½ ft.	Smooth	Extra early	Fair	Small, blunt	Home and Market Garden
Gradus	2½ ft.	Wrinkled	Early	Good	Medium, pointed	Home and Market Garden
Green Seeded Admiral	3½ ft.	Wrinkled	Mid-season	Good	Small, blunt	Canner, Sweet
Horsford's Market Garden	3 ft.	Wrinkled	Mid-season	Good	Small, blunt	Canner, Sweet
Hundredfold	1⅓ ft.	Wrinkled	Early	Good	Large, pointed	Home and Market Garden
Incomparable	3 ft.	Wrinkled	Mid-season	Good	Large, blunt	Home and Market Garden
Laxton's Progress	1½ ft.	Wrinkled	Early	Good	Large, pointed	Home and Market Garden
Little Marvel	1¼ ft.	Wrinkled	Early	Good	Small, blunt	Home and Market Garden
Mammoth Pod Extra Early	3 ft.	Smooth	Early	Fair	Medium, blunt	Market Garden
Mammoth Melting Sugar	3½ ft.	Smooth	Late	Good	Large, blunt	Edible pods
Nott's Excelsior	1 ft.	Wrinkled	Early	Good	Small, blunt	Home and Market Garden
Rice's No. 13	2½ ft.	Wrinkled	Mid-season	Good	Medium, pointed	Excellent Canner Variety
Rice's Early Dwarf	1⅔ ft.	Wrinkled	Early	Good	Medium, blunt	Home and Market Garden
Surprise or Eclipse	2½ ft.	Wrinkled	Early	Good	Small, blunt	Canner, Sweet
Sutton's Excelsior	1⅓ ft.	Wrinkled	Early	Good	Medium, blunt	Home and Market Garden
Thomas Laxton	2½ ft.	Wrinkled	Early	Good	Medium, blunt	Home and Market Garden
World's Record	2 ft.	Wrinkled	Early	Good	Medium, pointed	Home and Market Garden

two distinct types in use by the gardener and the canner—the smooth-seeded, and the wrinkled-seeded. In general, the smooth-seeded varieties are more hardy than the wrinkled and may be planted as soon as the soil may be worked in spring, while it is unsafe to plant the wrinkled sorts until the soil is somewhat warmer. The smooth-seeded varieties are relatively low in quality.

Other groups into which garden peas may be divided are based on length of season required for maturing the crop, length of plant, and size and shape of pod. There are also various types of edible-podded, or sugar peas. The following list, while it by no means includes all of the useful varieties, is representative of the more widely used sorts. New varieties are being developed with the object of securing high quality combined with resistance to disease. Some of these show much promise and will undoubtedly find a place in the garden and canning industry.

FIG. 165.—Thomas Laxton Pea. A valuable variety for the market gardener.

Isolate fields to prevent crosses.—The pea, like the bean, is nearly self-fertile, but under certain conditions two varieties grown in adjoining fields may cross to a small extent. To avoid this possibility it is wise to separate fields of peas growing for seed purposes by an intervening space of at least 40 rods.

Select a clean fertile clay loam or silt loam and fit thoroughly.—While peas will grow on a variety of soils, the heaviest crops are produced upon soil which is cool and retentive of moisture. Peas should be grown for seed in a long rotation in order to avoid loss from soil-borne diseases. Fertilize with commercial fertilizer high in phosphorus. Apply the fertilizer broadcast after plowing and thoroughly work into the soil. If the soil is at all acid in reaction apply lime as its need may be indicated. Peas will not grow well on acid soil.

Inoculate the seed before planting.—The pea being a legume, is able to utilize nitrogen obtained from the atmosphere through the action of bacteria. In the older pea-growing territory, it is quite likely that the bacteria are present in the soil, but when peas are sown in soil which has not previously grown this crop it is wise to use one of the commercial preparations of the special pea bacteria.

FIG. 166.—Rice's No. 13. A prolific canner "sweet" pea of high quality.

Plant clean seed early with drill at the rate of 3 to 4 bushels per acre, or in rows 28 inches apart for special selection work. Peas will not thrive in hot weather, hence, early sowing will advance the crop to a point where it is not injured by the extreme heat of midsummer. Seed sown in rows will produce a crop somewhat lower in yield than is produced

by a drilled crop, but one which is easier to inspect thoroughly in order to detect off-types.

Rogue for diseased plants and off-types.—To maintain a satisfactory stock of seed peas, it is essential that the crop be carefully rogued. A very few rogues, or off-types, in a canner crop of peas may result in a lowered value of the entire pack. A small percentage of early rogues will likely produce ripe seed before the balance of the crop is ready to harvest for canning. These hard peas cannot all be removed in the factory and those which find their way into the can will remain hard, even though they go through the regular processing. The best time to remove early rogues from a seed crop of canner peas is when they are coming into blossom. At this time, they may easily be seen. Late, coarse rogues in Alaska and other early pea varieties may best be seen and removed at the time when the crop is just starting to ripen.

Fig. 167.—World's Record Pea. The best variety of the Gradus type.

Certain varieties in use by the market gardener are likely to contain off-type plants of the type known as "rabbit ears." These are degenerate plants on which the pods are often slender and curved. The name "rabbit ear" is derived from the appearance of the stipules which instead of being round and somewhat flattened as in a plant of the true type are slender, upright and pointed. The "rabbit ear" rogue can best be seen and removed when the plants in the field are 6 to 8 inches tall before they have fallen over. Any

other plant in the field, which deviates from the true type of the variety, should also be removed.

There are a number of pea diseases which are seed-borne. Some of these may be detected in a growing crop. These diseased plants should be removed to prevent the disease from passing on to the next generation.

Harvest when properly matured, using a mowing machine equipped with vine lifters and windrowing attachments. The proper stage of maturity is at the period just before the vines have become dead ripe. If the crop is left until over-mature it is likely to shatter heavily, also the seed may have a dull, bleached appearance.

Cure the crop in the field and when thoroughly cured, store in a mow or in a well-covered stack. Thresh with a bean separator or with a specially equipped grain separator. The grain separator, as commonly equipped, maintains a high-cylinder speed, which is likely to cause splitting in peas. For threshing peas, the pulleys should be so arranged that, while the cylinder speed is relatively low, the shakers will be geared up to their usual speed.

Clean the seed with a properly equipped fanning mill.—If necessary, hand pick the crop to remove discolored seed. Store in a cool, well-ventilated storeroom.

If necessary, treat with carbon disulphide to kill weevil. The pea weevil, while it much resembles in appearance, the bean weevil, differs in that it produces but one brood each year. If the seed is treated and the weevils are all destroyed, the chances of infestation in the succeeding crop will be materially reduced.

Maintain breeding and increase plots.—There is no surer or better method of securing choice seed stock than by the increase of single plant selections. Select a large number of typical plants which are ideal from the standpoints of yield, season, type of pod and pea, and freedom from disease. Sow the seed of each one of the these plants separately and observe the growing progenies closely. If any one of the progenies show a devia-

tion from type in a single plant, this whole progeny should be discarded. Retain the progenies which show greatest uniformity in type, but keep each separate for succeeding sowings. Increase will be rapid and in a comparatively few generations, one may secure pure lines which will breed true in large quantities. Theoretically, it is possible, with care and without having

FIG. 168.—Pea Trials at McMillan, Mich. The vines are trained upright upon wire trellis in order to separate the rows, and to better judge the relative heights and other characteristics of the plants. (Courtesy of Seed World.)

losses, to produce in ten generations from a single plant, enough seed to sow 50,000 acres.

GENERAL INFORMATION

The pea is a native of Europe and Asia. It has been cultivated for food purposes since very ancient times. It was one of the first vegetables brought to America by the Colonists. It belongs to the order *Leguminoseae* and, hence, is closely related to the bean, clover, and alfalfa. Its popularity as a canner crop has rapidly increased. In the year 1925 the acreage grown

for canning purposes was more than 230,000 acres, with a production of 214,000 tons, having a farm value of $12,652,000. Of this crop, more than one-half was produced in the state of Wisconsin.

The garden pea belongs to the same species as the field pea and is subject to the same diseases and insects, which have been discussed in Chapter XIII.

CHAPTER XVIII

PRODUCING SEEDS OF GARDEN BEET AND SUGAR BEETS, SWISS CHARD AND SPINACH

GARDEN BEETS

The garden beet is one of the most important of the root crops. It is grown by the private gardener and the market gardener, and in recent years it has developed some prominence as a canning crop. Garden beet seed is comparatively easy to produce and a considerable amount is grown in California, Washington, and certain of the New England States. The production in America varies greatly from year to year, depending upon the price of the seed. When the price falls below a certain point, much of the seed used is imported from Europe; above that point, the American grower increases his seed acreage.

Choose varieties best adapted to the use of the truck gardener and canner.—The number of varieties in use in America is comparatively small. The truck gardener demands an extra early strain of uniform shape with small top and taproot and with good color. Among the popular varieties for the gardener may be listed, Extra Early Egyptian, Crosby's Egyptian, and Eclipse. Early Wonder and Boston Crosby are said to be improved strains of the old Crosby's Egyptian. Detroit Dark Red is standard with the gardener as a main crop variety and it is also one of the best sorts for the canner. In a good strain of Detroit Dark Red Beets, the roots should be nearly globular in shape with small top and taproot. The interior color of the root should be of a vivid scarlet color.

Select a clean fertile sandy-loam soil retentive of moisture

and free from acid conditions. The beet plant is very intolerant of acid condition in the soil and will not thrive when this is present. Plow early and fit thoroughly. Repeated harrowing of the soil in the early part of the season will destroy a large portion of the weed seedlings and will make the cultivation of the beet crop much easier.

Fig. 169.—Detroit Dark Red Beet. The standard main-crop variety for the market gardener and the canner.

Fertilize with a high-grade complete fertilizer applied broadcast at the rate of 500 to 1000 pounds per acre on the plowed surface and worked into the soil. The beet is a shallow feeder and develops at its best when there is an abundance of available plant nutrients in the soil.

Plant seed in late June or early July in drills 14 to 18 inches apart for hand cultivation or 24 to 28 inches for horse cultivation. Give frequent shallow cultivations beginning when the plants first appear above ground. When plants are well-established, thin the rows so that plants will stand 2 to 3 inches apart in the row.

Rogue the growing crop to remove all off-types. Many of these may be distinguished by the shape, color or habit of growth of the leaf which may differ in some respects from the normal type.

Harvest roots before they are injured by frosts.—The beet roots are quite tender and may easily be injured by freezing.

FIG. 170.—Crosby's Egyptian Beet, a valuable early variety for the market gardener. A root of this size is ideal for transplanting for producing stock seed.

Discard all off-type roots, those showing coarseness in top or root, that are not typical in shape or that have sprangly branched taproots in place of a straight slender root. Remove

the tops without injuring the center bud. Store the roots in pits and cover pit with strawy litter to prevent freezing.

When placing roots in pits, it is advisable to select a high well-drained site for the pit, preferably in a location which slopes toward the north, so that it may remain cool until as late as is possible in the spring. Dig a pit 12 to 20 inches deep, place therein a layer of beets, sift a layer of sand over these, then add another layer of beets, then of sand until the mound is 2 feet or more above the surface of the soil. Slope the sides to a narrow ridge and cover with 6 inches of soil, afterward adding a layer of strawy litter. Beets pitted in this fashion are much more likely to come through the winter in good condition and to start a strong, vigorous growth in the spring than if pitted in the same manner as for potatoes.

Remove the roots in the spring as soon as the center buds begin to show new growth.—Store in a moist, cool basement or building until ready for planting in the field. Test each root for interior color by removing a small core for inspection. A testing device may be made by taking a small brass tube $\frac{1}{4}$ inch in diameter and flattening one end for insertion in a wooden handle. The other end is split down the center to a depth of 3 inches one side is cut off and the edges of the remaining side are sharpened to an edge. This tester is thrust into the side of a root toward the center, given a half turn and then withdrawn. A small core will then be available for inspection. If the core shows zoning or striping with white, the root should be discarded. If it is of a solid red color, it may be replaced and the root retained for planting. When testing the roots by this method, it is advisable at the same time to snip off a large portion of the taproot, leaving the remainder about 1 inch long. It is believed that when planting a beet root, if the long taproot is doubled under or kinked, the plant does not make as vigorous growth nor produce as much seed. A short taproot is not likely to be kinked in planting.

Plant the roots in spring when all danger of frost is past.—Select a fertile clay loam or silt-loam soil, plow early and fit

thoroughly. Broadcast a high-grade complete fertilizer at the rate of 500 pounds per acre upon the plowed surface and work well into the soil.

Isolate fields to prevent crossing.—The beet plant produces an abundance of pollen which may be carried by the wind to a great distance. Seed fields of different beet varieties should be separated by an interval of at least one-half mile.

Plant the roots in rows 3 feet apart, spacing the plants 15 to 18 inches apart in the row. The roots may be planted by hand or by transplanting machine. Pack the roots thoroughly. In order to insure that this be done, it is well to place them in the ground at an angle of about 45°. The center bud should be just at the surface of the soil. Roots planted with a transplanting machine are not likely to be properly packed and it is advisable to follow immediately after the transplanter with a horse-drawn roller.

When transplanting beets in the field, do not allow the surface of the roots to become dry before planting. Protect with canvas covers so that the wind may not reach them. Roots of table varieties of beets which have become dry may start roots slowly and may be seriously injured, thereby reducing the amount of seed produced.

Give frequent shallow cultivation throughout the growing season and hand hoe to remove weeds from row.

When the plants reach a height of 18 to 24 inches, it is advised by some growers that the terminal buds be pinched out. It is believed that this will induce greater branching and a heavier production of seed.

Harvest the crop when two-thirds of the seed are ripe.—If left until over-mature, a large part of the crop may be lost by shattering. Cut with sickle and tie the plants in bundles and place in narrow shocks in the field. The crop may be left in the field until thoroughly cured. Cover the racks which are used to draw the bundles to the separator with canvas sheets, as when the seed is dry it shatters easily and much seed may be lost in handling, unless proper precautions are observed.

Thresh the seed with a properly equipped separator.—Clean as well as is possible with fanning mill, and finish cleaning with canvas belt. When the crop is well-cured, the stems become very brittle and many of them may be broken in short pieces when threshing. As they are of much the same diameter as the seed balls, they will pass through the same screens. A broad canvas belt is used to remove these stems. This is passed over rollers supported by a frame and is slowly rotated. The beet seed are dropped upon the belt from a hopper and if the belt is arranged at the correct angle, the seed balls will roll to the bottom of the belt, while the stems will lie flat and be carried over and dropped on the other side.

Fig. 171.—A Crop of Beet Seed as Grown in the Sacramento Valley of California.

Spread the cleaned seed out thinly in a well-ventilated building until thoroughly dry, then sack and store in a cool, well-ventilated storeroom.

Maintain breeding and increase plots.—The best of commercial strains of beets are by no means perfect and careful breeding is sure to result in much improvement. Select mother beets which are ideal in shape, season, color and type. Isolate these at great distances from each other, or protect each growing plant with a cloth-covered cage to prevent crossing. Test the progeny of each mother beet in separate rows and retain for increase those roots which more nearly resemble the ideal type.

For the production of large commercial crops of garden beet seed, the grower often plants seed from selected roots as previously noted, spacing the seed somewhat thickly in the row, so that the roots will not attain too large size. These roots are

FIG. 172.—An Isolated Mother Beet of the Detroit Dark Red Variety. Beet plants must be separated by great distance, at least ½ mile from other beets, to prevent cross-pollination.

stored in pits without removing the tops and are removed and planted in the following spring to produce the seed crop. If this method is used it becomes of greater importance to make sure that the seed used has been produced by selected and tested mother beets.

GENERAL INFORMATION

The garden beet is a native of Europe. It apparently did not come into a general use until comparatively modern times. It is first mentioned as being cultivated in Germany in 1558, and in England in 1576.

The beet is a biennial of the family *Chenopodiaceae* or goose-foot family. The sugar beet, mangel, Swiss chard, and garden beet belong to the same species and will freely intercross. Seed crops of any of these plants should not be grown close together. The beet is a biennial, requiring two years to produce a crop of seed. What is commonly known as a beet seed is really a fruit containing from two to six seeds, each seed surrounded by a corky calyx.

Fig. 173.—Beet Leaf Showing Lesions Caused by Leaf Spot. (Courtesy Dr. M. W. Gardner, Purdue Univ. Agri. Exp. Sta.)

Diseases and insects:

Leaf spot is perhaps the most serious disease which attacks the garden beet and which sometimes causes serious injury by destroying the leaf tissue. The practice of sanitary measures, cleaning up and destroying all beet refuse after harvesting a crop and practicing crop rotation will aid in control. Spraying with Bordeaux Mixture will also prove of benefit.

Beet leaf-miner is an insect which may sometimes cause considerable injury. The larvae burrow in the tissues of the leaf and when present in

large numbers may cause a stunting of the plant. As the insect is protected by the leaf tissue, no poison spray will reach it. Clean sanitation of the field, and destruction of crop refuse are beneficial in the control of this insect.

Webworms.—At least two species of webworms attack garden beet leaves. Spraying with arsenate of lead will aid in controlling these.

SUGAR-BEET SEED GROWING

Before the World War practically all the sugar-beet seed used in America was imported from Europe, most of it being of the Kleinwanzlebener or Vilmorin varieties produced in Germany and France.

With the cutting off of this foreign supply during the War period, the domestic production of sugar-beet seed in the United States became important and beet-sugar companies in the West and also in Michigan and Ohio developed seed production on a large scale, several companies producing more than half of their needs.

Although it was demonstrated that sugar-beet seed could be dependably produced under American conditions, the production of sugar-beet seed, nevertheless, declined rapidly in this country immediately after the War and trade relations were established with Germany and other European seed-producing nations.

At the present time the sugar-beet breeders of the United States Department of Agriculture, Office of Sugar Plant Investigations, and of experiment stations in Michigan, Colorado, and Idaho, are directing their efforts toward the production of strains of sugar beets which will resist disease and produce high yields of sugar per acre under American conditions.

Seed which produces beets of average sugar content can be secured from European sources and apparently sugar-beet seed production in the United States has not been put on the basis of successful competition with the cheap and fairly reliable supply of foreign seed. Many sugar companies continue, however, to grow a considerable amount of high quality seed.

Good sugar-beet seed must be produced from strains of beets carefully selected for highest sugar content. The first step in the production of sugar-beet seed is the selection of mother beets of high sugar content which will produce progenies equally high in sugar. A great number of beets are analyzed and the

FIG. 174.—Harvesting Stock Sugar Beet Seed from Individual Mother-beets, Fairfield, Washington. (Office of Visual Instruction U. S. Dept. Agric.)

best individual beets are carefully siloed in moist sand in the fall. The following spring these are planted separately and seed from each mother plant is preserved and planted the third year in plats numbered to correspond with the number of the parent plant. A remnant of seed of each strain is retained and numbered. The progeny of each strain is analyzed. The poorer strains are discarded and the good strains used in producing mother seed which is increased in sufficient quantity for planting on a large scale.

In planting beets for commercial seed purposes about 8 pounds of seed are used to the acre, planted in rows 18 inches

apart. The plants may be thinned to 3 or 4 inches apart or left unthinned to save labor. The small beets or stecklings are stored in moist sand, protected from freezing by layers of straw and earth, with ventilators every 8 or 10 feet along the top of the heaps. Early the following spring the mother beets are planted in fall-plowed land in rows varying from 30 to 36 inches apart with the beets the same distance apart in the rows. In planting, a spade is put into the ground and thrust forward, the steckling inserted and the earth pressed around so as to slightly cover the crown. Weeds are kept in check by thorough cultivation and hoeing.

In harvesting, the seed stalks are cut with a sickle and piled in the field to cure for threshing. Canvas sheets should be placed beneath the piles.

Threshing is accomplished with the ordinary grain separator. Yields of 600 to 1600 pounds per acre result during favorable seasons.

Under present trade conditions, the bulk of our common commercial sugar-beet seed is coming from Germany and will undoubtedly continue to do so until American plant breeders develop highly superior strains which will increase yields of sugar per acre to such an extent that higher price per pound of seed will not deter beet companies from growing or securing domestic seed or cheaper production methods are developed in the United States.*

PRODUCING SEED OF SWISS CHARD

A comparatively small amount of seed Swiss chard is produced in America, as most of the seed is imported from Europe. Swiss chard is closely related to the beet. It forms no fleshy roots but is used for its large tender green leaves and its fleshy

* According to Dr. Elmer Brandes, Chief of the Office of Sugar Investigation of the U. S. D. A., promising results in producing sugar-beet seed at low cost are being secured by planting in August or early September in areas of New Mexico, where the beet plants will winter-over without injury and produce seed the following growing season.

leaf stalks. It is especially adapted as a summer pot-herb since it is able to withstand hot weather better than any of the other vegetables used for "greens."

Operations:

Use the same methods, in as far as they may apply, as are recommended for the production of garden beet seed. Swiss chard is more hardy than the beet and in favorable locations the crowns may be wintered in the field, if they are given some pro-

FIG. 175.—Lucullus Swiss Chard, Note the Crinkled or "Savoy" Type of Leaf.

tection with strawy litter. Where winters are severe, the crowns may be lifted in the fall, stored in trenches and replanted in the spring.

Isolate the seed fields, not only widely separating two varieties of chard, but also growing them at a distance from any other form of beet.

Maintain breeding and increase plats.—There are two distinct types of chard, the plain leaf and the wrinkled or "Savoy" leaf type, with numerous variations of each type. Select superior individuals, isolate these as recommended for beets,

test the progeny of each separately and retain for increase the ones which more nearly conform to the ideal type.

PRODUCING SEED OF SPINACH

Adaptation, uses, importance:

Spinach is the most important of the pot-herbs grown in America and is rapidly increasing in popularity. It is included in the list of the twenty major vegetable crops of the United States. It is produced in vast quantities by the market gardener and the truck farmer, and is also used to a considerable extent by the canner.

According to the Year Book of the United States Department of Agriculture for 1925, there were planted for market in 1925, 30,250 acres; and for canning, 11,190 acres.

Spinach may be produced in almost any section of America. It is a plant which thrives best in a cool season and is not adapted for growing in hot weather.

Operations:

Choose varieties of highest yield and best quality.—There are four groups of spinach varieties which differ in a number of respects from each other.

The Norfolk Group includes the Norfolk Savoy and Bloomsdale which are much alike, if not identical. The plants in this group grow somewhat upright, with thick, crinkly leaves which do not rest upon the ground. There is a tendency in this group to bolt quickly to seed.

Group 2.—Round-leaved spinach. Plants are compact in habit of growth, with leaves close to the ground. Color—dark green. Slow-growing varieties which do not bolt to seed quickly. Victoria is a representative variety of this group.

Group 3.—Thick-leaved spinach. Plants are large, leaves long, broad ends and lobes of leaves pointed. This type is much in use by the canners as it produces heavy tonnage. Viroflay and Giant Thick Leaved belong to this group.

Prickly seeded spinach is included in the fourth group.

There is much variation in type within this group. The best-known variety is Prickly Seeded Winter, a variety of minor importance.

The most important commercial varieties are Bloomsdale,

FIG. 176.—Representative Plants of each of the Four Groups of Spinach. (1) Norfolk Savoy or Bloomsdale, (2) Victoria, (3) Giant Thick Leaf, (4) Prickly Seeded Winter.

Victoria, Viroflay, Giant Thick Leaved, King of Denmark, and Princess Juliana.

Isolate seed field to prevent crossing.—The spinach plant produces pollen in abundance, which is widely disseminated by the winds. To insure purity in strain, two varieties for seed should not be planted closer than one-half mile.

Select a fertile loam or silt loam, free from soil acidity, and fit thoroughly. The crop should be manured or grown in a rotation which includes a green-manure crop, as it is desirable to have an ample supply of humus in the soil. Early plowing and thorough fitting will insure a good seed bed and will aid in destroying the weed seedlings which may be present in the soil. Spinach is somewhat intolerant of acid conditions in the soil

FIG. 177.—Long Standing Variety of Spinach. Field properly thinned for seed production. (Grass Lake Seed Farm, Mich.)

and lime should be applied, if needed, to correct an acid condition.

Fertilize with a high-grade complete fertilizer at the rate of at least 1000 pounds per acre. In order to secure profitable seed crops of this vegetable it is essential that the soil be very rich in available plant nutrients.

Plant seed in early September in sections where spinach may be successfully wintered in the field. In the more northern

regions it is safer to delay planting until early spring. The seed may then be planted as soon as the soil is in condition to work. Plant in drills 24 inches apart and when the plants are well established, thin the rows, spacing the plants 6 inches apart in the row.

Give frequent and shallow cultivation.—If necessary, remove weeds from the rows with hand hoes.

Rogue for off-type plants.—This should be done before the plants begin to bolt to seed. The off-types can be more easily seen when in the "rosette" stage, and early removal will prevent crossing.

Dust with nicotine dust, if aphids are present in the field. Hydrated lime containing 3 per cent nicotine will give fairly good control. The amount of dust required for 1 acre will sometimes run as high as 40 pounds.

If winters are severe, mulch plants for protection, using straw or other coarse litter. In the more southern sections of California, where a large part of the spinach-seed crop is grown, this practice is not necessary. Remove the mulch in the spring, cultivate and keep free from weeds.

Harvest when properly matured.—The crop should be cut when a large proportion of the seeds are ripe, but should not be allowed to become over-mature. Cut with scythe or with mowing-machine.

Cure in small piles in the field.—When thoroughly dry, store the crop in mow or in well-protected stacks. Thresh with a thoroughly clean grain separator and clean with fanning mill. As the seeds grow in clusters and sometimes stick together, it may be necessary to rethresh with flail the clusters which run over the "scalper" sieve of the fanning mill.

Spread seed out thinly and stir occasionally until thoroughly dry, then store in cool, well-ventilated storeroom.

Maintain breeding and increase plots.—The spinach plant is ordinarily dioecious. As a rule, the female plants are more valuable to the gardener in that they form large rosettes and have broad, thick leaves. The male plants vary much in type,

many of them shooting up to a blossom stem without forming a dense rosette. These are called " spindles " by the gardener. A poor strain which carries a large number of spindles is undesirable. All inferior male plants should be removed from breeding plots before they have formed pollen. In a number of strains of spinach, certain of the plants are monoecious. These plants resemble the female type, and effort should be made to increase this form.

GENERAL INFORMATION

History and botanical discussion.—Spinach has been under cultivation as a food plant since very ancient times. It is a native of Asia and was introduced into Europe early in the twelfth century. It is an annual plant belonging to the family *Chenopodiaceae* and is closely related to the beet and also to the various common weeds of the pigweed or blite type.

Insects and diseases:

Beet Leaf Miner.—This insect may sometimes become a serious pest. It is common to both beet and spinach. See discussion under " Beet."

Spinach Aphis.—This insect is a variety of plant louse. It not only may cause serious injury to the plant by sucking the juices, but it is also known to carry spinach blight from plant to plant. It breeds and increases very rapidly and unless control measures are adopted when it is first observed, it may quickly destroy large areas in the seed field. Dust plants with nicotine dust as previously recommended in this chapter.

Spinach blight or Mosaic.—A serious disease of spinach and one for which there is no known means for control. It is carried from diseased to healthy plants by insects, especially by aphids. A strain of spinach which is resistant to this disease has been developed at the Virginia Truck Experiment Station. This strain is now available under the name " Virginia Savoy." Where the blight is a limiting factor in the production of a crop, it is recommended that this variety be planted.

CHAPTER XIX

GROWING SEED OF CARROTS, PARSNIP, CELERY, PARSLEY, AND OTHER UMBELLIFEROUS PLANTS

GROWING SEED OF CARROT

Adaptation, uses, importance:

The carrot may be grown over a wide range of territory. It is a vegetable which is rapidly growing in popularity as knowledge of its great value in the diet is more generally understood.

The carrot is grown in nearly every home garden. It is an important crop for the market gardener, and it is highly regarded as a food for live stock. The carrot is included among the twenty most important vegetable crops grown for market. The farm value of the 1925 crop approximated $4,000,000.

Choose varieties of highest yield and best quality.—Carrot varieties vary much in shape, size, color, and season of maturity. The two main classes are the pointed rooted and the premorse or stump-rooted type. These classes are again divided into long, half-long, and short types. In color the carrot may be red or orange, purple, yellow, or white, according to the variety.

While seedsmen list many varieties, there are few of these which are of great importance. A large proportion of the carrots grown for the market are of the Chantenay and the Danvers half-long varieties. The Chantenay produces a tapering blunt-ended root which is somewhat short and broad at the top. The Danvers carrot is longer in proportion to thickness with less taper. It is also stump-rooted. The Nantes is a variety which produces a slender, cylindrical, blunt-ended root with small top. This variety is valuable for forcing, and is recommended for home gardens as it has a very small core and a cor-

respondingly greater part of cortex, the outer part of the root which contains a large part of the valuable food elements. Oxheart, Rubicon, Early Scarlet Horn, and St. Valery, or Intermediate are other market garden varieties of more or less importance. With the exception of St. Valery, which is pointed-rooted, these are stump-rooted. Long Orange, a long, pointed-rooted variety, produces a heavy yield and is much

Fig. 178.—A California Carrot Field in Blossom.

grown for stock feeding. White Belgian and Yellow Belgian produce large roots. These are also used for live stock.

Select a rich loam, silt loam, or muck soil and fit thoroughly. Fertilize with a high-grade complete fertilizer rich in potash.

Plant the seed in early summer in drills 14 to 18 inches apart for hand cultivation or spaced somewhat wider for horse cultivation, using 2 to 3 pounds of seed per acre. Carrot seed

are somewhat slow in germinating and it is often desirable to mix a small quantity of radish seed with the carrot seed before planting. The radish seed will germinate quickly and cultivation may be begun sooner.

Thin the plants to stand 2 to 4 inches apart in the row.—This will allow for better root development.

Give frequent shallow cultivation, starting as soon as the rows may be seen. Hand weed the rows when necessary to control weeds.

Remove the roots from the field before danger from frost injury.—The roots are easily damaged by freezing and will quickly rot if frosted.

Sort the roots carefully and discard all roots which are not true to the type of the variety.

Top the roots, taking care to leave the center bud uninjured and store in pits or root cellars at a temperature slightly above the freezing-point. The atmosphere of storage house should be somewhat moist. In California, where much of the carrot seed of the United States is grown, it is a general practice to top the roots, place them in sacks and store in a cool place until planting time.

Isolate seed fields to prevent crossing.—Carrot varieties readily intercross and will also cross with the wild carrot. Certain sections of the East are unsuited for the production of carrot seed on account of presence of wild-carrot plants in large numbers.

Select a clean, fertile, well-drained loam for seed field and fit thoroughly. Fertilize with 500 to 1000 pounds per acre of a complete fertilizer high in phosphorus.

Transplant the roots when danger of hard frosts is over in rows 3 feet apart, spacing the roots 6 to 10 inches apart in the row. As with all transplanted crops, it is necessary that the roots be well packed in the soil. With the carrot as well as with other large roots, packing may be accomplished better if the roots are placed in the soil at an angle of 45°. The crown should be even with the top of the soil.

Give frequent shallow cultivation.—Remove weeds from the rows with hand hoe.

Harvest the crop when a large proportion of the seed clusters are mature. Cut by hand and cure in the field until thoroughly dry.

Thresh with flail, taking pains to prevent the stems from breaking up, as the small pieces are difficult to remove from the seed. Clean by rubbing over sieves, or with special cleaning machinery. Give a final cleaning with fanning mill. If seed is thoroughly dry it may then be sacked and stored in a cool, well-ventilated storeroom.

Maintain breeding and increase plots.—When sorting roots before storing, reserve the very finest specimens for strain improvement. Plant these roots in isolated places. Save the seed from each plant separately. Plant a small portion of each lot of seed for testing progenies and reserve the best lots for further increase. With the finer table varieties, the core should be very small and the cortex, or portion surrounding the core should be relatively large. Much improvement in quality of a strain may be made if roots with small cores are used for increase. To determine the proportion of core to cortex in the mother roots, a small cylinder may be cut cross-wise through the center of the root as recommended for the beet.

GENERAL INFORMATION

History and botanical description.—The carrot is believed to be a native of Europe, Asia, and North Africa. While it was known to the ancients and was probably used for food, it did not become of importance until the sixth century, when it was cultivated in England. The carrot belongs to *Umbelliferae* or parsley family. It is a biennial, producing a seed stalk the second year.

GROWING SEED OF PARSNIP

Adaptation, uses, importance:

The parsnip is adapted to the cooler sections of the country and, hence, it is not grown over as wide an area as is the carrot. It is a hardy vegetable and may be left in the ground over winter. The flavor is said to be improved by freezing. The parsnip ranks very high in food value. It is an important vegetable in the home garden and is extensively grown by market gardeners, although it is not equal to the carrot in popularity, due to the fact that it is a slow-growing vegetable which occupies the soil during the entire season. In addition, the parsnip, while very high in food value, is disliked by many people on account of its flavor.

FIG. 179.—A Typical Parsnip Plant Showing Habit of Growth and Manner of Producing Blossoms in Dense Umbels.

Choose seed of highest quality and most desirable variety. Comparatively few distinct varieties of parsnips have been developed. A good strain of Hollow Crown is in greatest demand. The Guernsey is a strain of Hollow Crown in which the roots are somewhat shorter. The Early Round is quite distinct. It is a short-round variety of little importance.

Isolate seed fields to prevent crossing.—This is of especial importance in sections where the parsnip has become naturalized as a weed.

Select a deep, fertile, well-drained sandy loam and fit thoroughly. Fertilize, using 400 to 500 pounds of high-grade, complete fertilizer per acre.

Plant the seed in early spring in drills $3\frac{1}{2}$ to 4 feet apart, using 2 to 4 pounds of seed per acre. Use seed from crop of preceding year as older seed is likely to be lacking in vitality. Mix a small quantity of radish seed with the parsnip seed, so that cultivation may be given early. Parsnip seed is slow to germinate.

Thin the plants to stand 6 to 8 inches apart in the row.—This may be done when the plants are well established at an age of six to eight weeks.

Give frequent shallow cultivation throughout the growing season. Remove weeds from the rows by use of hand hoe. Allow the roots to remain in the ground over winter and resume cultivation in the spring.

Harvest when properly matured.—When a large proportion of the seed heads become brown and the stems begin to dry the crop is ready for harvesting. Cut by hand and cure in the field or in open sheds. Thresh the seed when dry, using flail or machine equipped with proper screens. Clean the seed with fanning mill and spread out thinly on canvas or tight cloth until thoroughly dry, then sack and store in a cool, well-ventilated storeroom.

Maintain breeding and increase plots.—In order to secure high quality in stock-seed, it will be necessary to dig a portion of the crop and from this select perfect roots, symmetrical in shape with broad crowns and uniform taper. It is of especial importance that the selected roots be unbranched, or without forks, and free from coarse side-roots. Plant the selected roots in an isolated field and reserve the seed from these for stock-seed purposes.

GENERAL INFORMATION

History and botanical description.—The parsnip is a native of certain portions of Europe. It is also believed to be native

to South America and to northwestern United States and Canada. It has been used for food from very ancient times. The parsnip is a biennial belonging to *Umbelliferae* or parsley family and, hence, is related to the carrot, celery, and many other cultivated plants. The family, *Umbelliferae*, includes many wild species that are very poisonous. It is believed by many people that the cultivated parsnip becomes poisonous the second season. It is quite likely that cases of poisoning attributed to the parsnip are due to the use of the poison hemlock which is sometimes mistaken and eaten for parsnip. As the seed stalk of the parsnip matures, it contains a poisonous principle which may cause some discomfiture to the men who harvest the crop. The effect of the poison will usually quickly disappear and the swollen hands will soon return to normal size.

GROWING SEED OF CELERY

Adaptation, uses, and importance.—Celery is one of the most popular of the salad crops, in this class ranking next to lettuce in importance. Its use is rapidly increasing from year to year and as it is a vegetable which may be successfully stored for a considerable period of time it is found in the markets on practically every day of the year. It thrives best during the cooler seasons of the year. It is grown as a summer and fall crop in the North and as a winter and spring crop in the South and in California. Celery requires a combination of a very fertile soil with an ample supply of water in the soil at all times, hence, a large part of the crop is grown on the rich muck and peat soils of New York, Michigan, and California. According to the statistics of the Division of Crop Estimates, the acreage grown for market in 1925 was 22,600 with a farm value of $12,491,000.

Choose clean seed of highest quality and best varieties.——There are comparatively few distinct varieties of celery. Of these, Golden Self-blanching is by far the most important, over 50 per cent of the commercial crop being of this variety. Golden Plume or Wonderful somewhat resembles Golden Self-blanching in appearance, but is larger in habit of growth. It

blanches quickly to a golden color. The various sorts of the Easy Blanching type much resemble each other. They blanch quickly and are best adapted to fall and early winter use. Giant Pascal is the leading winter variety. Other winter sorts of somewhat less importance are Emperor, Winter Queen, Boston Market, and French's Success.

FIG. 180.—The Late Dr. W. W. Tracey, Formerly of the Bureau of Plant Industry of the U. S. Dept. Agric., Inspecting a Field of Celery. Dr. Tracey was an acknowledged authority on types and varieties of vegetables. His ideals of type have been widely accepted by the seed industry.

Select a clean fertile loam or muck for seed bed and fit thoroughly.

Sterilize the soil before sowing the seed, using formaldehyde, steam, or hot-water treatment.

Disinfect the seed before sowing.—Septoria blight is often carried in the seed. The hot-water treatment will prove fairly effective although it will somewhat reduce the percentage of germination. Since the disease spores are likely to be dead on two-year-old seed, the use of old seed of good germination is recommended.

Sow the seed in early May.—Soaking the seed before sowing will hasten germination and this practice is followed by many growers. Sow the seed on the surface of the soil and lightly rake it in. If the soil shows a tendency to dry rapidly it may be covered with burlap cloth until germination takes place.

Spray the plants in the seed bed to control disease, using a 4–4–50 Bordeaux Mixture.

Transplant to the field in early July, selecting a fertile moist soil, such as a deep silt loam or muck. Plant in rows 3 to 4 feet apart, spacing the plants 6 inches apart in the row. Until recently, it has been the practice to transplant by hand.

Recently transplanting machines have appeared which work successfully.

Fertilize heavily with a complete fertilizer according to the needs of the soil. As much of the peat or muck soil is low in potash, the use of a fertilizer rich in this element is recommended.

Give frequent shallow cultivation throughout the growing season. Remove the weeds from the rows with hand hoe.

Spray the plants at intervals of ten days to two weeks, using a 5–5–50 Bordeaux Mixture prepared with a soap sticker. Use a sprayer with sufficient pressure to insure that the entire surface of the plant is covered with the disinfectant.

Rogue the field for off-type plants.—Remove the green-leaved varieties from the fields of yellow sorts, and vice versa. Especial care must be taken to rogue out plants with hollow or pithy stalks, as this character is likely to be inherited in succeeding generations. Plants showing symptoms of Mosaic disease should also be removed from the field and destroyed.

Remove the plants from the field before danger of freezing. Store in trenches or cold frames and protect from freezing. Select a protected, well-drained location and prepare narrow trenches about 1 foot in depth. Place the plants upright in the trenches, covering the roots with soil. Nail two 12-inch boards together in the form of a V and place over the plants so as to furnish some air and ventilation. As cold weather approaches,

cover the boards with earth and litter to a sufficient depth to prevent freezing; or, place the plant upright in a cold frame, covering the roots with soil, and protect with covering of boards and mats. Care must be observed that the plants be dry when placed in trench or frame.

Fig. 181.—Celery Plant as it Produces Flower Clusters.

In California, where much of the celery seed is produced, the plants are set in the field early in the year and are allowed to produce seed as annuals. Hence, winter storage is not practical in this section.

Select a well-drained sandy loam for seed field and fit thoroughly. Fertilize with a complete fertilizer high in phosphorus.

Isolate fields to prevent crossing, if more than one variety is grown in the same locality.

Transplant the plants when danger of hard frosts is over in rows 4 feet apart, spacing them 18 inches apart in the row.

Give frequent shallow cultivation and keep the rows free from weeds by use of the hand hoe.

Harvest at the proper stage of maturity.—As the seed heads mature somewhat unevenly, the plants may be cut when a large proportion of the clusters have turned brown. Cut the stalks carefully by hand to prevent shattering of seeds.

Cure the crop in the field on canvas sheets, or if the weather is unfavorable, spread thinly in open sheds until thoroughly dry.

Thresh with flail on canvas or with a properly equipped separator.—Clean the seed with fanning mill. Spread the clean seed out thinly on cloth or board floor and stir frequently until it is dry enough to sack, then place in sacks and store in a cool, well-ventilated storeroom.

Maintain breeding and increase plots.—Select the finest plants from the growing crop, store separately, and plant in

FIG. 182.—Making Plant Selections in Celery Seed Field in California. (Courtesy of Seed World.)

isolated positions. Save the seed of each plant separately, plant a small portion of each lot of seed in test plot, and reserve for increase those lots which prove to be the best in trial.

GENERAL INFORMATION

History and botanical discussion:

Celery is native to a large part of Europe, Asia, and Africa. It has also been found growing wild in South America, in California, and in New Zealand. While celery was used in olden

times as a medicinal plant, it was not cultivated as a food plant until a comparatively recent date. In 1623 it was first listed among the food plants of France.

Celery is a biennial plant belonging to the family *Umbelliferae* and, hence, is related to the carrot, parsnip, and to many of the aromatic herbs such as fennel, dill and others.

Diseases and insects:

Celery is subject to a number of diseases including late or septoria blight, early blight, bacterial blight, heart rot, damping off, storage rot, and yellows. Seed disinfection followed by spraying with Bordeaux Mixture will control most of the field diseases. Plants which are kept free from disease in the field and are placed in storage with the leaves free from moisture will better withstand the effects of storage diseases than those which are allowed to become infected in the field and are later improperly handled. Rotation of crops and proper field sanitation will aid in control of disease.

The celery yellows is becoming a serious disease in some sections. The causal organism lives in the soil for an indefinite period and under favorable conditions of soil and temperature may cause a loss of an entire crop. The green varieties of celery are less injured by this disease and may often produce profitable crops on infected soil. The new yellows-resistant strain of Golden Self-blanching celery which was developed at the Michigan State Experiment Station has proved to be very resistant to this disease.

GROWING SEED OF PARSLEY

Uses, adaptation, importance:

Parsley is largely grown as one of the garden herbs. The leaves are used for flavoring, in salads, and as decorations for other dishes. The Hamburg, or turnip-rooted parsley, is used for its root, which is produced much in the same manner as the carrot and is used largely by the foreign population for flavoring soups and stews as well as for other edible purposes.

Parsley is a biennial crop, producing seed during the second year. The plants may be wintered over in trenches or in cold frames in sections where the winter is severe. In California, where a large part of the seed crop is produced, the plants may be successfully wintered in the open ground.

There are three distinct types: the curled leaf, the plain-leaved, a coarser growing sort, the leaves of which are used for seasoning; and the Hamburg or turnip-rooted variety.

For seed production, plant in rows 3 feet apart, spacing the plants 1 foot apart in the row. Give clean cultivation. Rogue the growing crop and remove all off-type plants.

Harvest, cure, thresh, and store the seed much in the same manner as described for celery.

Parsley is an aromatic herb belonging to the family *Umbelliferae.* It is a native of Europe and has been cultivated in gardens for more than 2000 years.

GROWING SEED OF DILL

Dill is an aromatic herb belonging to the family *Umbelliferae.* It is used largely by the commercial pickle-packer to impart flavor to the dill pickle. Dill is grown to a small extent by the market gardener and in the home garden.

For the production of a crop for seed, the seed is planted in early spring where the crop is to be produced. The rows are spaced $2\frac{1}{2}$ to 3 feet apart and the plants are thinned to stand 6 to 8 inches apart in the row. Give clean cultivation and weeding throughout the growing season. Harvest, cure, thresh and store the seed in the same manner as described for parsnip.

Among other plants of the family *Umbelliferae* which are cultivated in a limited way are included: Chervil, both plain and curled leaf (an aromatic herb much resembling parsley and used in the same manner for garnishing and flavoring), Florence Fennel (a vegetable, the thickened bulb-like leaf stems of which are blanched and used like celery), and many herbs

including Anise, Caraway, Coriander, and Sweet Fennel, the aromatic parts of which are used for flavoring. Much of the seed of these plants is produced abroad, although they may be grown successfully for seed in this country. The cultural practices in the production of seed of these plants is much the same as described for other members of this family.

CHAPTER XX

GROWING SEED AND SETS OF ONION, LEEK, GARLIC, SHALLOT, CIBOUL OR WELSH ONION, CHIVES

GROWING SEED OF ONION

Uses, adaptation, importance:

The onion is the most important of the bulb crops and ranks fifth in commercial value of the vegetable crops grown in the United States. The average annual acreage occupied by the growing of commercial crops of onions is approximately 60,000 acres, nearly 46,000 of which are planted to the so-called domestic types, while the balance is of the Bermuda or other foreign types. In addition to this there are few home gardens which do not include a small planting of onions. There is perhaps no other vegetable which is more widely grown, as there are varieties adapted to almost any soil or climatic condition. The onion is used while immature in the form of green or bunch onions. When ripe, it may be used raw as a salad, or cooked and served in a variety of ways. The onion crop may be grown directly from seed sown in the ground where the crop is to mature, from sets grown from seed during the previous year, from top sets which in certain varieties are produced in the flower head, and from bottom sets, as in the case of the multiplier or potato-onion.

Seed of the so-called domestic types of onion may be grown to advantage in almost any one of the more northern states and a number of these, including Ohio, Oregon, Colorado, Connecticut, Washington, Illinois, and Michigan, are annually producing considerable amounts of high-grade seed. A large proportion of the seed crop is grown in California where season

and climatic conditions seem to be favorable for the production of high yields of seed. It is believed by many seedsmen that, if onion seed is grown for several continuous generations in California, there is a tendency toward deterioration in type and strain, and for this reason certain of the western seed growers make it a practice to renew their seed stocks by frequent importations of high-class seed grown in the East or North. It is quite possible that if deterioration does take place in western-grown seed, it may be due to careless selection of bulbs on the part of certain growers as well as to environmental conditions.

FIG. 183.—Types of Globe Onions.

Upper left, Southport Yellow Globe; Upper right, Yellow Globe Danvers; Lower left, Southport White Globe; Lower right, Michigan Yellow Globe.

Seed of the foreign Bermuda types of onions is little grown in this country, most of it coming from abroad, mainly from the Canary Islands. Seed of the Spanish varieties is produced largely in Spain, although in recent years very satisfactory seed of the Valencia type has been produced in New Mexico, Arizona, and Utah.

Choose seed of highest quality and best varieties.—As the onion is grown over a wide territory, a large number of varieties have been developed. The yellow sorts are more largely grown commercially and among the

better varieties may be listed the Southport Yellow Globe, the Ohio and Michigan Yellow Globe, and the Yellow Globe Danvers. The Yellow Strasburg is largely used for the production of yellow onion sets. The Prizetaker was originally of Spanish origin, but as now grown it has developed many of the qualities of the domestic types. The Southport Red Globe and the Red Wethersfield are the important red varieties, the latter being used for producing red onion sets, as well as bulbs for winter storage. The Southport White Globe and the White Portugal or Silverskin are the principal white varieties. The White Portugal produces a large, flat, white onion and is also used for the production of white onion sets and for small pickling onions.

Select a loose, fertile soil which is retentive of moisture, such as a silt loam or muck, and fit thoroughly. Especial care should be directed toward the production of a finely prepared seed bed, which is free from sticks, stones, or other trash which might interfere with cultivation.

Fertilize heavily, according to the need of the soil.—Much of the bulb crop is grown in a muck or peat soil and as this is likely to be deficient in potash, the use of a complete fertilizer rich in potash is often advisable.

Sow the seed in drills 14 inches apart for hand cultivation, or 18 to 24 inches for horse cultivation, using from 3 to 5 pounds of seed per acre. Sow the seed when danger of hard frosts is over. As the onion is comparatively hardy, the seed may be sown early in the season. As a rule the early sown seed produces the largest crop of bulbs.

Give frequent, shallow cultivation, starting when the plants first appear above the ground. Hand-weed the rows when necessary to prevent the growth of weeds.

Harvest the bulbs at the proper degree of maturity, as evidenced by the breaking over of the tops and the mature appearance of the bulbs. Cure in the field and remove the tops.

Select only bulbs of the best type for the variety, discarding all off-types. In selecting the bulbs of the globe varieties, it

is of especial importance to discard all bulbs which show a tendency toward a flattened shape. All bulbs which have thick necks should be avoided for seed production, as this character may be inherited through succeeding generations.

Plant in the field in early fall, or in a locality where severe winter weather prevails, store the bulbs in a frost-proof storage house and plant in early spring. The conditions demanded for successful storage of onion bulbs are: a cool temperature, preferably just above the freezing-point, and good ventilation, to insure a dry atmosphere. In the warmer sections of California, the bulbs are stored in sacks until required for planting, which may be at any time in late fall or early winter.

Isolate the seed fields to prevent crossing.—An interval of at least 40 rods should be maintained between fields of different varieties. This is of especial importance when varieties of different colors are grown in the same locality.

Select a fertile silt-loam or clay-loam soil and fit thoroughly. Fertilize with a complete fertilizer high in phosphorus.

Plant the bulbs in rows 3 to $3\frac{1}{2}$ feet apart, spacing them 6 to 8 inches apart in the row. Plant upright in shallow trenches, so that, when the bulbs are well covered, the top of the bulb will be about 6 inches below the surface. If the bulbs are planted in the fall, at the approach of winter, ridge the soil over the rows for greater protection. Level the ridges in early spring. Give frequent shallow cultivation until the seed stalks are well grown. Remove weeds from the row with hand hoe.

Harvest the seed crop when at the proper stage of maturity.—This may be determined by the appearance of the seed capsules, which begin to break open and disclose the ripe seed within when mature. If left too long before harvesting, much seed may be lost through shattering. Cut the seed stalk just below the head, using a sharp knife, and place the heads in barrels or sacks for removal from the field. Spread the heads thinly in an airy, well-ventilated storehouse until thoroughly dry. In localities where rainfall is infrequent at harvest time, the seed heads may be cured on canvas sheets in the open air.

Thresh the seed with flail, or with specially equipped separator and clean as well as possible with fanning mill. Immerse the seed in water and stir gently. The light seed and trash will float to the surface where it may be removed, the plump, heavy seed will sink to the bottom of the vat from whence it may be drained into a sieve to remove the surplus water. Spread the cleaned seed thinly on cloth sheets in the sun, stirring frequently until thoroughly dry. Give a final cleaning through a fanning mill and sack and store in a cool, well-ventilated storeroom.

Maintain breeding and increase plots.—Select the most desirable bulbs from the crop, plant in an isolated field, save the seed from each bulb separately and plant each in a separate plot the following year. Reserve the progenies of the best-producing bulbs for future increase. If greater perfection be desired, the individual heads may be self-pollinated if covered with cloth to prevent crossing. Through several generations of selfing, comparatively pure lines may be built up in which are combined the most desirable characteristics of the variety.

GROWING ONION SETS

Select clean seed of adapted varieties.—While onion sets may be produced from almost any variety of onions, the varieties in most common use are Yellow Strasburg, White Portugal or Silverskin, and Red Wethersfield.

Select a fertile, clean, sandy loam and fit thoroughly.—Fertilize with stable manure in the fall and fall plow. Prepare a fine seed bed in early spring and work it down to a good condition of tilth.

Sow seed early in spring in broad drills 8 to 12 inches apart, using from 40 to 75 pounds or more of seed per acre. On poorer soils, less seed is used. On very fertile soils, certain growers use up to 100 pounds of seed per acre. The best sets are those $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in diameter. Smaller sets produce weak plants, while sets greater than $\frac{3}{4}$ inch in diameter are

undesirable. The size of the set is largely regulated by adjusting the rate of seed sowing to the fertility of the soil.

Give frequent shallow cultivation and keep the rows free from weeds.

Harvest the sets at the proper stage of maturity as indicated by the tops beginning to soften and drop. Use a cutting blade attached to a wheel hoe to loosen the sets. Gather in baskets and place in shallow, slatted trays to dry.

Cure in the slatted trays, leaving the sets exposed to the sun

FIG. 184.—Onion Sets Drying on Racks in Field. (Courtesy of Seed World.)

for a day or two, after which the trays may be racked up in piles in the field and the piles covered with a temporary roof.

When the sets are thoroughly dry, clean by rubbing over a screen. This will remove adhering dirt and most of the tops. Finish the cleaning and grading by use of fanning mill.

Store the sets in slatted crates in a dry, well-ventilated storeroom at a temperature just above freezing.

PRODUCING SETS OF VARIOUS TYPES OF MULTIPLIER ONIONS

This group is of minor importance. The bulbs are seldom produced from seeds, but are propagated by the segregation of

the bulbs into smaller bulblets. These bulblets are again used for producing bulbs for increase.

Egyptian or perennial onion is reproduced from small bulblets which form in the cluster on top of the seed stalk in place of seed. Plant a permanent bed, remove the bulblets when mature, cure and store much in the same manner as for onion sets.

GENERAL INFORMATION

History and botanical discussion:

The onion is believed to be of Asiatic origin. It is one of the oldest of vegetables and has been cultivated for food purposes since the earliest period of history. It is mentioned in the Bible as one of the things which the Israelites longed for in the Wilderness.

The onion belongs to *Lilaceae* or the lily family and to the genus Allium. This genus includes many biennial and perennial species which are cultivated for food purposes. Many species of wild onions are native to North America.

Diseases and insects:

Onion Smut is perhaps the most destructive disease of onions. It is more or less prevalent in many of the onion-growing regions in the North. It persists in the soil and attacks the young seedlings.

Onion smut can be controlled by applying a solution of formaldehyde (1 pint of commercial formaldehyde to 16 gallons of water) in the furrow with the seed. A tank is attached to the seed drill with a small tube which conducts a stream of the solution just in front of the covering attachment of the drill. Two hundred gallons of the solution is the usual application per acre.

Onion Mildew is a fungus disease which sometimes attacks the onion, causing the affected plants to turn yellow and finally die. Spraying with fungicides has not proved to be very effective. Burning the infected tops and rotation of crops are recommended measures of control.

Onion Thrips are small insects which sometimes attack the leaves of onion plants, giving them a whitened appearance. These insects may cause much injury to the crop, especially during a dry season. They are somewhat difficult to control. Spraying with tobacco extracts and soap, when the insect first appears, or dusting with a 4 per cent nicotine dust may aid in preventing serious injury. If spray or dust be used it is best to make application during a bright, sunny period in midday, as at this time the insects are more active and are more easily reached.

Onion Maggot.—The onion maggot is the larva of a small fly, which lays its eggs in the soil at the base of the onion plant. Since the maggot works in the inside of the plant, it is difficult to reach with poison, hence, the best method of control is to kill the fly by use of poison bait before the eggs are laid. A recommended bait is made as follows: $\frac{1}{5}$ ounce Sodium Arsenite, 1 gallon water, 1 quart molasses. Dissolve the Sodium Arsenite in boiling water and add the molasses. Place the poison in small pans, using 15 to 20 pans per acre.

GROWING SEED OF LEEK

Adaptation, uses, importance.—The leek is a biennial. It is grown for its blanched leaves and stems which are used much in the same manner as green onions, or cooked as flavoring for soups. It is produced by market gardeners mainly for the use of the foreign population. The mild, agreeable flavor of the leek would seem to justify a much greater consumption of this vegetable. Much of the seed used in America is produced in Europe, although good crops may be grown in this country, especially California.

Choose highest quality seed of best varieties.—A number of varieties are listed by American seedsmen, good strains of which are much alike. The large Carenten and the Musselburgh are popular varieties. London Flag and Scotch Flag are also recommended.

Isolate seed bed to prevent crossing if more than one variety be grown in a locality. Forty rods between varieties should be sufficient.

Select a fertile, well-drained loam or silt-loam soil and fit thoroughly. Fertilize with a complete fertilizer high in phosphorus.

Sow the seed early in spring in a well-prepared seed bed and when plants are well-developed, transplant in rows 18 to 24 inches apart, spacing the plants 6 inches apart in the row, or sow the seed in drills the same distance apart and thin to 6 inches in the row.

Give frequent, shallow cultivation and remove weeds from row with hand hoe.

Throw a light furrow over the row for winter protection in localities where winter is likely to be severe. Remove the ridge in early spring. The leek is fairly hardy and under conditions of mild winter weather no protection may be needed.

Cultivate frequently the second year until the seed stalks become so large that cultivation may cause injury.

Harvest the crop when mature and treat seed in the same manner as described for onions.

GENERAL INFORMATION

History and botanical discussion:

The leek is believed to be a native of southern Europe. It has been under cultivation since prehistoric times. It belongs to *Lilaceae* or lily family and to the genus *Allium*, hence, is closely related to the onion and garlic.

There are a number of vegetables closely related to the onion which are used but to a small extent in America, among which are garlic, shallot, ciboul or Welsh onion, and chives.

Garlic is a hardy perennial plant native to the Mediterranean region of Europe. It has a strong flavor and odor and for this reason it has not become a popular vegetable.

It produces seed similar to the onion. The seed stalk bears

both seed and small bulblets in the same head. The bulb differs from that of the onion in that it is formed of many small bulblets or cloves, which are covered with an outer skin. The seed is seldom used for propagation, as it is customary to plant the bulblets in much the same manner as onion sets are planted. Cultivation, soil, fertilization, and care should be much the same as for onions.

When the bulbs are ripe they are pulled. As soon as the tops are dry they are braided into long braids and hung up for further curing.

The Shallot is believed to be a native of Asia. It is a perennial which seldom produces seed. It is propagated from small bulblets into which the bulb divides. Cultivation and care are much the same as for the onion.

The Ciboul or Welsh onion is a perennial, but is usually grown as an annual or biennial. It produces seed much as the onion. It may be propagated by division, or by use of seed. The latter method is preferred. The Ciboul is probably a native of Asia. It does not produce a large bulb, but is grown for its leaves, which are used in salads.

Chives is a perennial of the onion family. This vegetable is grown for its leaves which are used for seasoning. It forms a dense mass of small bulblets which is divided for propagation purposes. Chives sometimes produces seed, but the small amounts of this vegetable which are used here are usually obtained by division of a clump.

CHAPTER XXI

GROWING SEED OF LETTUCE, ENDIVE, CHICORY, SALSIFY, ARTICHOKE

GROWING SEED OF LETTUCE

Lettuce is the most important of the salad crops. The annual acreage devoted to the growing of this vegetable has greatly increased during the past twenty years. In 1909 there were 5489 acres of lettuce valued at $1,595,085, while in 1925 the acreage was approximately 86,400 with an estimated farm value of $24,767,000. Letuce is very valuable in the diet by reason of the fact that it is rich in vitamins and minerals salts, and while formerly considered a spring crop, its usefulness has now been extended to cover nearly every day in the year.

Choose seed of highest quality and best varieties.—Tracy has divided lettuce into three classes: Butter varieties, Crisp varieties, and Cos varieties. The first two classes are each divided into two sub-classes—the cabbage-heading and the bunching varieties, and these sub-classes are again divided into color divisions. The Cos varieties are divided according to shape of leaf and habit of growth. The most important of the butter varieties are: Big Boston, Unrivalled, California Cream Butter, Tennis Ball (both black and white seeded), Deacon, May King, and Wayahead. Each one of these varieties is catalogued under various synonyms. Black Seeded, Tennis Ball, and Salamander are much alike, if not identical. The Big Boston is more largely grown commercially than other members of this group.

The important crisp-heading varieties are New York, Hanson, and Iceberg. The New York variety has many synonyms.

Much of the lettuce grown commercially in California under the trade name " Iceberg " is not the true Iceberg, which has a deep brownish tinge in the outer leaves, but is the New York—a wholly green variety. The varieties known as Los Angeles and Wonderful are similar, if not identical to New York.

The bunching varieties are largely used for greenhouse forcing or for the home garden. The most important varieties are Grand Rapids, Black-seeded Simpson, and White-seeded

Fig. 185.—New York Lettuce on California Ranch of C. C. Morse & Co. Selected plants are caged to prevent cross-pollination. (Courtesy of Seed World.)

Simpson. White Paris Cos is the most important variety of this class.

Select a loose, well-drained sandy loam or silt-loam soil and fit thoroughly.—Fertilize heavily with a complete fertilizer high in phosphorus.

Plant seed early in the season.—In California, where a large proportion of the lettuce-seed crop is produced, plant the seed in February or early March. In the East, seed planting must

be delayed until April. Plant in rows 20 inches to 24 inches apart and as the plants become well established, thin them to stand 15 inches apart in the rows.

Give frequent shallow cultivation and use hand hoe to remove weeds from the rows.

Rogue the fields at the time when the plants are fully developed, but before they have started to bolt to seed. Remove and destroy all plants which diverge from the true type for the

FIG. 186.—Field of Lettuce Seed on Pieters-Wheeler Ranch in California. (Courtesy of Seed World.)

variety, more especially those plants which show a tendency to quickly send up a seed stalk.

With dense, close-heading varieties, cut the top of the head in form of a cross with a sharp knife, taking care not to cut so deeply as to injure the center bud. This will enable the bud to break through and send up a straight stalk.

Harvest the seed crop when it has reached a proper degree of maturity.—This may be determined by the yellow appearance of the seed head. Cut the stalks by hand, lay on cloth

sheets and allow the seed heads to become thoroughly dry before threshing.

Thresh when dry, using flail, or roller on canvas.—If large quantities are grown, use a properly equipped, clean separator. Clean the seed with a fanning mill, sack, and store in a cool, well-ventilated storeroom.

Maintain breeding and increase plots.—Select superior plants from the field and transplant to properly isolated locations or cover seed heads with cloth to prevent cross-pollination. Test the progeny from individual selections separately and increase the more desirable lots. While lettuce is an open-pollinated plant, very little crossing normally takes place in the field. However, in the production of choice seed stocks, it is necessary to use methods for the protection of the blossoms from possible contamination.

GENERAL INFORMATION

History and botanical description.—Lettuce is one of the oldest of cultivated crops. It is considered to be a native of Europe and Asia and has been under cultivation for at least 2500 years. References to this vegetable extend back to 500 years B.C. It was highly valued for its medicinal qualities as well as for its use in the diet. Lettuce is an annual belonging to the *Compositae*, or Sunflower family. It is closely related to the wild lettuce and it is believed that crosses with this type may take place in the field. Besides the three classes mentioned, there is another type known as Asparagus lettuce, which is grown for its stem.

Diseases and insects:

There are a number of diseases which attack the commercial crop, but which are seldom troublesome in the field if proper rotation be followed. Among these may be noted: Bottom rot, drop, gray mold, anthracnose, mildew, and tipburn. Mosaic disease may sometimes cause serious damage. As this is principally carried by a species of aphis, the principal

method of control would seem to be through the destruction of the aphis through the use of a 2 per cent nicotine dust.

The most important of the insect pests are the various species of aphis. These may be controlled by the use of nicotine dust. If cut worms prove to be troublesome, they may be destroyed by the use of a poisoned bait.

GROWING SEED OF ENDIVE

Endive is a vegetable crop of somewhat minor importance in the United States. It is grown by market gardeners and to some extent in home gardens. The curled varieties are blanched and used in salads, while the broad-leaved types are largely used for potherbs or greens. Much of the seed used in the United States is produced in Europe, the balance is grown largely in California.

Choose seed of highest quality and of best varieties.—The most important of the curled varieties are the Green Curled Winter, the Giant Fringed, and the White Curled. Of the broad-leaved sorts, the Broad-leaved Batavian is the best known. This is often sold in the market under the name of Escarole. The use of this term is sometimes extended to cover all types of endive.

Select a well-drained sandy loam or silt-loam soil and fit thoroughly.—Fertilize with a high-grade complete fertilizer high in phosphorus.

Isolate the seed fields to prevent crossing.—Not only should fields of different varieties be separated, but care should be taken to prevent crossing with volunteer plants which may develop from shattered seeds of a previous crop.

Plant the seed thinly in drills 2 feet apart and when plants are well established, thin them to stand 18 inches apart in the row. In California, plant the seeds in February or early March. In the North, plant in mid-April.

Give frequent, shallow cultivation and remove weeds from the row with hand hoe.

Rogue the fields at the time when the plants are just starting to bolt to seed. Remove all plants which are untrue to type and those which show a tendency to form early seed stalks.

Harvest the seed when the bulk of the crop is mature.—The seed clusters are formed on short stems in the axils of the leaves and the earliest clusters are likely to shatter before the later ones are mature. Good judgment must be used to determine the proper stage for harvesting without too great a loss. Cut the stalks and cure in field on canvas sheets, or after the crop is partially cured it may be removed to a well-ventilated storage barn where curing may be completed.

Thresh, when dry, with flail or with a clean separator.—Clean the seed with fanning mill and store in a cool, well-ventilated storeroom.

Maintain breeding and increase plots.—Select superior plants and remove them to isolated fields or protect the flowering heads with cloth covering to prevent crossing. Test the progeny of each plant separately and save for increase the seed from plants which prove to be superior.

GROWING SEED OF CHICORY

Chicory is a vegetable of minor importance. There are two types which, although they belong to the same species, vary somewhat in habit of growth. The Witloof type is grown for its leaves, which are forced in the winter time and used for salads under the name "French Endive." The large-rooted Magdeburg is the most important variety of its type. The roots are dried, roasted and used as a substitute for coffee. Much of the seed used in America is produced in Europe, although it may be successfully grown in the United States.

Choose seed of highest quality and best variety.—Select Witloof or large-rooted Magdeburg according to the use for which the seed is designed.

Plant the seed in early spring in fertile sandy loam or silt-loam soil and grow roots as described for carrots. Store the

roots in pits over winter and transplant in early spring in rows 24 inches apart spacing the plants 15 to 18 inches apart in the row.

Cultivate and treat seed crop the same as for endive.

GENERAL INFORMATION ON CHICORY AND ENDIVE

History and botanical description.—Chicory is probably a native of Europe and Asia. It has long been used as a salad plant. Endive is one of the older of the cultivated plants. It is considered to be a native of the East Indies and was cultivated at a very early date by the Egyptians and the Greeks. It belongs to the *Compositae*, or Sunflower family.

GROWING SEED OF SALSIFY

Uses, adaptation, importance.—Salsify, sometimes known as vegetable oyster, is cultivated for its root which has a flavor somewhat similar to that of the oyster. The roots are high in food value. Salsify produces heavy crops when planted in deep rich soil and as the roots are hardy they may be left in the ground over winter or dug and stored in the fall for winter use.

Choose best variety.—The variety Mammoth Sandwich Island is the important variety in use in America. Scorzonera or Black Salsify, a closely related vegetable, is sometimes grown in Europe, but is little known in the United States. Scolymus, or Spanish Oyster plant, a member of the same family but of a different genus, is grown and used in much the same manner as salsify. It produces a larger root which is somewhat more delicate in flavor. The leaves of Scolymus are large and somewhat prickly.

Isolate seed fields to prevent crossing.—While it is likely that but one variety is grown in quantity in America, there is a tendency for volunteer plants to be produced from shattered seed of a previous crop. These should be avoided, as they may be very inferior.

Select a deep, well-drained sandy loam or silt-loam soil and fit thoroughly. Fertilize with high-grade complete fertilizer or with acid phosphate on well-manured soil.

Plant seed in drills 30 to 36 inches apart, using a hand seeder

Fig. 187.—Isolated Plant of Salsify as it Produces Seed Stalks.

or a properly equipped drill. Plant early as salsify requires a long season to mature good strong roots.

Cultivate as soon as the rows can be followed, and thereafter give frequent shallow cultivation. Remove weeds from row with hand hoe.

Thin the plants in the row as soon as they are well established, spacing them to stand 8 to 10 inches apart in the row.

Leave the roots in the ground over winter as they are perfectly hardy and will withstand low temperatures.

Cultivate as soon as the soil can be worked the following spring and keep the crop free from weeds.

Harvest the heads as they mature, cutting by hand. As the heads mature very unevenly, it may be necessary to go over the field twice daily in order to prevent loss of seed through shattering. Spread the heads thinly on canvas in the field to cure. When partially dry they may be spread thinly on floors under shelter until dry.

Thresh with flail or with specially equipped machine.—Clean the seed through fanning mill, sack, and store in a cool, well-ventilated storeroom.

Maintain breeding and increase plots. A portion of the crop of roots may be dug in spring and the most perfect roots selected for improvement in strain. The selected roots should be straight and tapering and of good size. All roots which are forked, or which have coarse side roots, should be rejected. The selected roots may be transplanted in an isolated field and the seed saved for further increase.

GENERAL INFORMATION

History and botanical description:

Salsify is a native of southern Europe. Its first cultivation dates back to comparatively recent times as it was little known until the fifteenth century. It is a hardy biennial plant belonging to the *Compositae*, or Sunflower family and the seed heads, when opened, much resemble those of the dandelion although much larger.

There are few insects or diseases which cause serious injury to this plant. Birds are very fond of the seeds, especially the Yellow-bird, and they may sometimes cause injury through shattering the mature seed heads.

GROWING SEED OF ARTICHOKE

Uses, adaptation, importance.—Artichoke or globe artichoke is a perennial plant. It is grown for its immature flower heads, the scales of which are thick and fleshy. The globe artichoke is a vegetable much in use throughout southern Europe, but is little grown in America. Practically all of the seed produced in the United States is grown in southern California.

Secure slips from high-grade producing plants.—Artichokes may be grown directly from seed, but the plants do not always come true from seed. Seed of better quality is likely to be produced from slips taken from superior plants.

Plant in early spring in well-prepared fertile soil, in rows 4 feet apart, spacing plants 2 feet apart in the rows.

Give frequent shallow cultivation throughout the growing season.

Harvest by hand, cutting off seed heads as they mature. Cure on canvas sheets in the field.

Thresh when thoroughly dry, using flail. Clean seed with fanning mill, sack, and store in well-ventilated, dry storeroom.

History and botanical description.—The artichoke is a native of southern Europe. In habit of growth it somewhat resembles a thistle plant as the leaves are coarse, notched, and prickly. It is a rather tender perennial of the *Compositae* or Sunflower family. In the South it winters well in the open, but in the north it should be well protected. A closely related plant, the Cardoon, resembles artichoke in appearance of plant and habit of growth, but it is used for its blanched shoots, which are gathered in early summer.

CHAPTER XXII

GROWING SEED OF ASPARAGUS, OKRA AND RHUBARB

Adaptation, uses, importance.—Asparagus may be grown over a wide range of territory. While it may be grown on almost any type of soil, it thrives best on a low, but well-drained, loam or silt loam. It is used for its young shoots, which are produced early in spring. It is found in many home gardens, is produced in quantity by the market gardener, and is rapidly growing in favor with the canner. It is an important vegetable to the grower, but one of minor importance to the seed trade as it is a long-lived perennial, which does not have to be renewed each year. Much, if not all, of the seed which is used is produced as a by-product from commercial plantings which are grown primarily for market. There is no doubt but that the same careful methods of plant breeding used by the seedsman to produce choice strains in other vegetable varieties would be equally valuable in improving strains of asparagus.

Choose seed of best varieties of highest quality.—The Washington strains are bred for rust resistance and of these the Mary Washington is perhaps the most desirable, as it produces a larger percentage of fancy stalks.

Select a fertile, well-drained sandy-loam soil and fit thoroughly. Fertilize with a high-grade complete fertilizer, applying at the rate of 500 pounds per acre.

Plant the seed thinly, in early spring, in drills 12 to 15 inches apart, for hand cultivation, or 24 to 30 inches apart for horse cultivation. As the seed is slow in germinating, mix a small quantity of radish seed with the asparagus seed. The radish seed will germinate quickly and will serve to mark the rows, so that cultivation may quickly begin.

Give frequent shallow cultivation throughout the growing season and keep rows free from weeds. Thin the plants to stand 3 inches apart in the row.

Allow the plants to remain in seed bed over winter, but dig them early in spring before growth starts and remove to permanent plantation. Discard all but the strongest and most vigorous plants. Isolate the seed field.

Select a deep, rich, well-drained loam soil; plow deeply and fit thoroughly.—Lay out the rows 5 feet apart and form a trench 10 to 12 inches deep, along each row, using plow twice in the row, place the plants 2 feet apart in the bottom of the trench and cover with 2 inches of soil; cultivate frequently during the growing season. As the plants develop, add more soil to the trench until, by the end of the season, the trenches are level with the surface soil.

Fertilize heavily each succeeding year, and keep the field free from weeds and insect pests. The third year a commercial cutting may be made for market. The summer and fall top growth will produce a crop of seed if conditions be favorable.

Harvest the crop when the tops have been killed by frost, cutting the seed stalks by hand. Premature cutting of the tops may cause injury to the roots and will seriously curtail the succeeding year's crop.

Remove the berries from the stalk by beating with flail on floor or canvas. Crush the berries by pounding in a vat or tub until the seeds have been loosened from the pulp. Wash the seed by placing a quantity of the seed in a barrel. Fill the barrel nearly full of water and stir vigorously. Afterward allow a short time for the seed to settle. The skins and pulp may then be poured off. Rinse in clear water and spread the seed out thinly to dry. After the seeds are dry, clean and grade by running through the fanning mill. Reject all light and undersized seeds, keeping the plump and heavy ones. Sack and store in a cool, well-ventilated storeroom.

Maintain breeding and increase plats.—When the plants have become well established in the seed field, stake and mark

a number of the plants which produce large numbers of fancy stalks, selecting them in the proportion of one male to three female plants. Remove these plants in the fall after growth has stopped and group them together in an isolated field. If the crowns are large, they may be divided, each one making several plants.

Cultivate, fertilize, and otherwise treat the field as previously described and reserve the seed crop for future increase.

GENERAL INFORMATION ON ASPARAGUS

History and botanical discussion:

Asparagus is native to a large part of Europe and Asia. It may be found growing wild over vast areas of Russia and Siberia, where it is eaten by the horses and cattle as a forage plant. Asparagus was highly esteemed as a food by the Greeks and Romans. It has been known and cultivated for at least 2000 years.

Asparagus belongs to *Lilaceae* or the lily family. It is a hardy, perennial, dioecious plant, the male and female blossoms being borne on separate plants. The fruit is a berry which becomes red as it matures.

Diseases and insects:

The one most serious disease of asparagus is the rust. The development of rust-resistant strains has reduced the loss from this disease to a very small amount.

Asparagus is attacked by two species of beetle, the common asparagus beetle and the 12-spotted asparagus beetle. A judicious use of arsenical sprays will greatly aid in keeping these insects in check.

GROWING OF SEED OKRA

Adaptation, uses, importance.—Okra is a comparatively tender plant and thrives best in the more southern sections, although certain of the more quick maturing sorts may be suc-

cessfully grown in the North. The mucilaginous properties of the immature seed pods make okra useful in thickening soups and stews. The pods are sometimes stewed alone and eaten as a vegetable. Okra is a vegetable of minor importance both to the gardener and to the seedsman. The principal demand for Okra seed comes from the South, where okra is a more common article of diet. The seed is produced mostly in Georgia and Alabama. A little seed comes from New Jersey.

Choose seed of best varieties and highest quality.—Perkins Mammoth is a popular sort. Extra Early Dwarf is useful in the North. White Velvet produces long white pods.

Select a warm, fertile sandy soil. Sow seed in early spring in rows 3 to 5 feet apart. Thin the plants to stand 15 inches apart for dwarf varieties, 30 inches apart for tall. Rogue the fields and remove all plants which are not true to type of variety. Practice clean cultivation.

Harvest the crop when the plants have been killed by frost. Cut the plants by hand and remove to barn or shed for curing. Thresh when dry, using a separator or a corn sheller. Clean with fanning mill and store in a cool, well-ventilated storeroom.

GENERAL NOTES ON OKRA

Okra is considered to be a native of Africa and possibly Asia. It is not mentioned in ancient records but was in use by the Spaniards and the Egyptians in the twelfth century. Okra belongs to the *Malvaceae* or mallow family and to the genus *Hibiscus*, hence it is related to cotton, and to various well-known flowering plants.

GROWING SEED AND ROOTS OF RHUBARB

Adaptation, uses, Importance:

Rhubarb is largely grown in home gardens in the North, and by market gardeners as a field crop and for winter forcing. As it thrives best in cool locations it is not in general use throughout the South. Rhubarb is grown for its thick leaf stalks

which are used for pies and sauces. It is not an important vegetable and as it is a perennial, it is not often replanted by the grower, hence the demand for seeds and roots is very small.

Seedsmen handle both roots and seeds. A large proportion of new plantations are propagated from roots, for as rule but a small percentage of plants come true from seed.

GROWING ROOTS OF RHUBARB

Choose a deep, rich, sandy loam soil and fit thoroughly. Fertilize heavily, as rhubarb is a gross-feeder. Select the choicest clumps from an old-established plantation, dig these in spring and divide into smaller plants. A piece of root with one good bud makes a good plant. Plant the roots 3 to 4 inches deep in rows 4 to 6 feet apart, spacing the plants 2 to 3 feet apart in the row. Combine clean cultivation with heavy fertilization and at the end of two or three years the clumps may be dug and divided into plants for use in the trade, and at the same time, new plantations may be set out for further propagation. If seed is used, plant the seed of rhubarb early in spring in rich, well-drained soil, spacing the rows 15 to 18 inches apart for hand cultivation, or 30 inches for horse cultivation. Maintain clean cultivation during the season. As the plants develop, rogue out and destroy all types which are undesirable, retaining the plants which produce long thick petioles or leafstalks, which are deep-pink in color throughout their length. The second year the selected plants may be removed to the permanent location. The established bed may be allowed to produce seed each year. The seed is allowed to mature on the plant. The seed stalks are then removed from the plant and are cured until dry. The seed may be threshed by flail, or with separator. Clean with fanning mill, sack and store.

GENERAL NOTES ON RHUBARB

Rhubarb is a native of Siberia. It belongs to *Polygonaceae* or buckwheat family. Rhubarb is a hardy perennial and when

once established will last over an indefinite period. There are a number of varieties recognized by the seed trade which, although they do not breed true, are quite distinct in many respects. The most important of these are the Victoria and the Linnaeus. The Victoria produces large stalks and is considered to be a late variety. The Linnaeus ranks as early, the stalks are smaller than Victoria and as a rule are more highly colored.

GROWING SEED OF MARTYNIA, OR UNICORN PLANT

The martynia is grown to a slight extent as a curiosity in home gardens. The pods are used for pickling when small and immature. Plant seed in a warm, fertile soil in rows 3 feet apart. Thin plants to stand 18 to 24 inches apart in the row. Give clean cultivation and harvest when seeds are fully mature.

CHAPTER XXIII

WHERE THE NATION'S SEED IS PRODUCED

The possibilities of commercial seed growing in the United States have been only slightly developed and when the economics of the case warrant, the industry in its many features will find ample room for expansion.—R. A. Oakley.

In order to produce the ten-billion dollar annual crop harvested from the nation's fields and gardens, it is estimated that in excess of fifteen billion pounds, or over $500,000,000 worth, of seed is required. At least 75 per cent of this seed is produced on the farm; field crop seed—corn, wheat, oats, rye, barley, potatoes, cotton, etc., entering the seed trade to but a comparatively slight extent, in view of their immense total.

Forage-crop seed and garden-, canning- and truck-crop seed are, on the other hand, distributed in a large proportion by the seed trade, and it is not the common practice to raise these seeds on the farm where the market or feed crop is produced. Of the $500,000,000 worth of seed planted yearly, from $15,000,000 to $18,000,000 worth (chiefly forage-crop and vegetable seeds) are imported from foreign countries.

The producers of such crops as the cereals and potatoes generally reserve, from their market product, enough seed for the planting of their crop the following year—securing such advantage as is possible by selection and proper cleaning and storing on the farm.

In case of seed shortage, the commercial supplies of these crops, commonly used for food purposes, can be drawn upon.

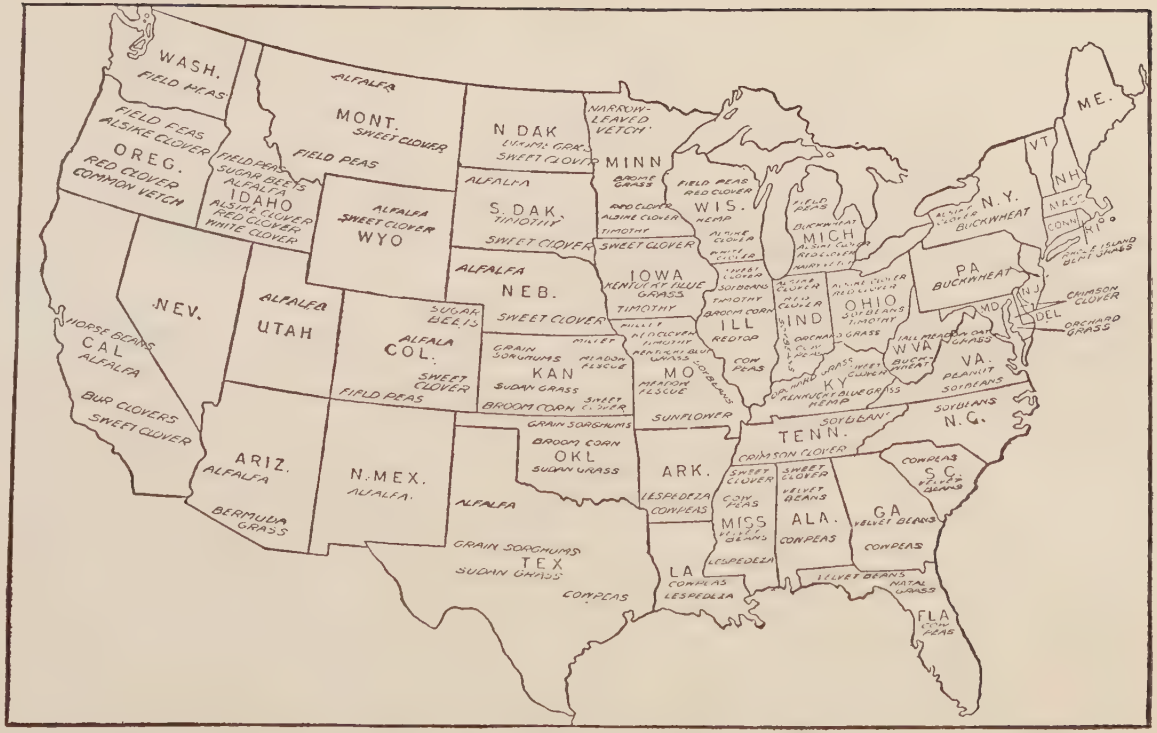

FIG. 188.—Producing Regions of Grain and Forage Seed Crops. (From The Seed Supply of the Nation, by R. A. Oakley, U. S. Dept. Agri. Year Book, 1917.)

Seed production of these crops is, hence, nearly as widespread as their commercial production, with the exception of the extensive use of northern-grown seed potatoes. An increasing percentage of seed of the cereals and potatoes is being produced for local distribution by specialized seed growers.

Forage crops are grown primarily for hay, pasture, and cover purposes and seed production of these crops is, therefore, developed in areas best adapted to the production, curing, and shipping of seed, and must keep pace with the actual seed needs of the nation for planting purposes.

The seeds of these crops have comparatively little commercial value for other purposes than planting.

In view of specialized production, the necessity of thoroughly cleaning forage crop seeds, financing the carry-over and distributing to wide distances, these seeds are now, and undoubtedly will always be, handled by highly trained growers and seed dealers.

With the exception of a few crops such as beans and peas, truck, garden and canning crops are grown for their leaves, pulpy parts or immature fruits. The seed must be specially produced and conserved, and no reserves from the commonly used product exist to be drawn upon for seed purposes in case of need, as with the cereals.

Vegetable seeds are handled almost entirely by seedsmen and their production is limited to highly trained seed growers located in favorable producing areas, with the exception of limited production by a few large gardeners and canners.

Since vegetable stock seeds can be controlled for a larger period, more attention has been paid to the breeding and improvement of garden and truck crop seeds by commercial seedsmen than to breeding field crop seeds, the latter being largely left to government and state or provincial Experiment Stations.

In answer to the commonly asked question, "Why is it that every farmer does not raise and plant his own seeds and thereby save for himself the profit others usually derive in selling him seeds?" Mr. Geo. C. Edler gives the following reasons:

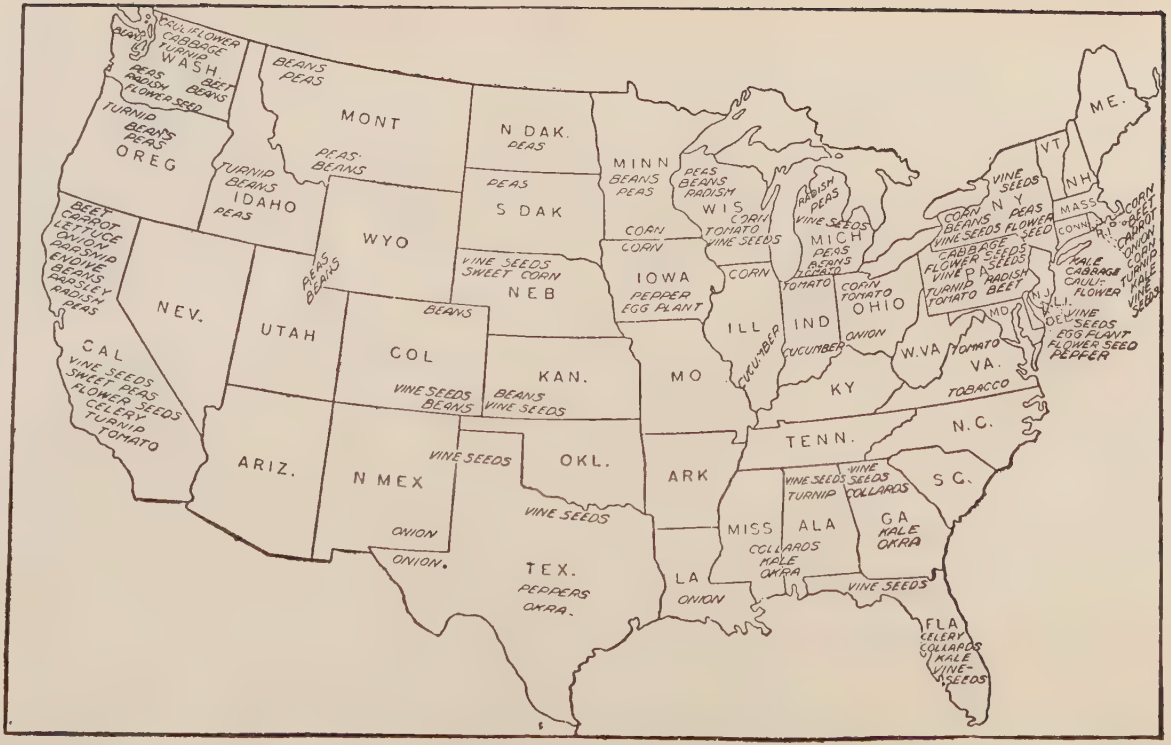

FIG. 189.—Producing Areas of Garden, Truck and Canning-crop Seeds. (From The Seed Supply of the Nation, by R. A. Oakley, U. S. Dept. Agri., Year Book, 1917.)

" (1) His fields may be foul with noxious weeds; (2) soil, climatic, and other conditions on his farm may be unfavorable for seed production in a given year; (3) altitude, latitude, or rainfall in his locality may preclude the production of a particular kind of seed in any year; (4) he may be able to buy better seeds at a lower cost than can be produced in his locality; (5) he may find it more profitable to grow a crop for hay or forage purposes than for seed production; (6) he may not have the facili-

FIG. 190.—Crop of Icicle Radish Seed Growing from Selected, Transplanted Roots. The roots are grown in seed bed until they reach marketable size. They are then pulled, the inferior roots discarded, and the desirable roots are planted in an isolated field for seed increase. (Courtesy of Jerome B. Rice Seed Co.)

ties for harvesting, cleaning, curing, or otherwise preparing his seed for planting purposes; (7) he may need seed of a crop that has not been grown by him for several years, if ever at all; and (8) he may have to replant his fields either with the same kind of seed, his supply of which may have been exhausted with the first planting, or with seed of some catch crop.

" In general, farmers obtain their seed from three sources, namely, from their own farms, from other farmers, or from deal-

ers. The percentage that is obtained from each of these three sources varies considerably with the kind of seed under question and the locality where the seed is planted. The Bureau of Markets of the Department of Agriculture made an extensive survey in this connection and published detailed figures relative to it in the *Seed Reporter* for July and October, 1919. The following table gives percentages of each of five important classes of seeds that indicate the relative importance of the sources from which farmers in various geographical divisions obtain these seeds."

TABLE I

NORMAL SOURCES OF SEED SUPPLY *

Group of States	Grasses			Clovers and alfalfa			Millets			Forage sorghums			Small grains		
	From own farm	From other farms	From dealers	From own farm	From other farms	From dealers	From own farm	From other farms	From dealers	From own farm	From other farms	From dealers	From own farm	From other farms	From dealers
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Eastern	5	2	93	6	3	91	3	1	96	1	0	99	44	12	44
Southern	6	4	90	11	5	84	12	6	82	36	13	51	45	15	40
Central	23	12	66	30	18	52	20	11	69	25	12	63	76	15	9
Northern	69	13	18	18	16	66	13	10	77	5	5	90	78	14	8
Far Western	4	2	94	12	9	79	7	3	90	16	18	66	59	15	26

* From "Seed Marketing Hints for the Farmer," Farmers' Bulletin No. 2,312, by Geo. C. Edler, Specialist in Marketing Seeds.

GENERAL SEED PRODUCTION

The production of seed of corn, wheat, oats, barley, rye, rice, and other cereals coincides with the areas of commercial production of these crops. The local adaptation of varieties, and the comparative effectiveness and cheapness with which the informed farmer can select and handle his own seed of these bulky seed crops, preclude the handling of a very large proportion of the cereal crop seeds by seed dealers.

Seed corn is best handled by selecting in the field from healthy, properly matured plants before frost damage occurs, and curing and storing under well-ventilated conditions. Many corn growers still select seed from the general crop at husking time or from the crib, practices which give fair results in good seasons, but which result in seed corn of low germination when early fall frosts or a wet fall season occurs.

Because of the many varieties and definite local adaptation of corn varieties, the great majority of corn growers find it advantageous to handle their own seed. There is opportunity, however, for the successful development of a local seed-corn business for many growers who specialize in seed-corn production and for seed dealers who handle seed corn for certain definite territories according to its adaptation.

In some years, as in 1917 and 1926, adverse fall seasons occur and a widespread seed-corn shortage results, giving an unusual opportunity to the seed-corn grower or dealer, supplied with well-handled seed, for service and profit. During the average year there are always a number of farmers who fail to select seed corn or whose supply is injured in germination and who must, hence, buy seed.

In the northern part of the corn-growing regions, where it is difficult to secure and handle well-matured, properly dried seed corn, commercial seed-corn growers and dealers handle a much larger percentage of the seed planted. Seed of silage corn in northern and eastern states enters trade much more than in the case of corn grown for grain in the Corn Belt. Seed of the bulkier types of ensilage corn is often produced in the Corn Belt for sale in northern localities to those desiring the large growing ensilage types. On the whole, seed-corn production is distributed throughout corn-growing regions.

Seed wheat also is produced throughout the wheat-growing regions and varieties are of comparatively local adaptation. Only during years of adverse seasonal conditions, affecting the general crop of large territories, does seed wheat enter trade channels to a large proportion of the seed planted. In the war

years of 1917–18, when winter killing severely affected winter wheat in many Corn Belt and northern states, and drought injured the spring wheat crop in the northwest and west central states, the Secretary of Agriculture cooperated with farmers and the seed trade and wheat best suited for seed was withdrawn from the commercial market and reserved for later distribution for planting.[1] Only in case of such an emergency do seed dealers handle any large proportion of the seed wheat.

Rye, oats, barley, buckwheat, and **rice** are largely grown and saved for seeds in the regions where these crops are of commercial importance.

Any unusual demand for increased production of wheat, rye, oats, buckwheat, or other cereal as was brought about by War conditions, results in increased acreage and an increase in the commercial handling of cereal seed to supply new territories and new growers.

FORAGE CROPS SEED PRODUCING REGIONS

Though hay and pasture crops are grown throughout practically the whole of the United States and Canadian agricultural regions, seed production of these crops is not undertaken by the average grower producing them for hay and pasture, but is quite markedly developed in areas best suited to seed production and handling, or in regions where skill in seed production has been developed and cleaning and marketing agencies built up. It is not practical for many average growers to undertake the production of seed of forage and pasture crops, even if fair yields may result under their soil and climatic conditions, since their fields may carry too high a proportion of noxious weeds and cleaning and marketing facilities may not be available.

Alfalfa seed is grown chiefly in regions where soil and climate favor a copious development of seed. Montana, Idaho,

[1] The Seed Supply of the Nation. R. A. Oakley, U. S. Dept. Agric. Year Book—1917.

the Dakotas and the high mountain basins of Utah, and the states of Kansas, Nebraska, and Colorado produce most of the alfalfa seed consumed in the Corn Belt and Northern States. Alfalfa seed production is increasing in Ontario, Michigan, Wisconsin, and other regions of the humid area, but, for the most part, seed production has developed in regions where the moisture supply is deficient and can be controlled by irrigation and to soils well supplied with lime and the mineral elements of fertility needed in seed formation. Arizona, Texas, Colorado, New Mexico, California, and Nevada produce the alfafa seed adapted to the Southwest and extreme South.

Alfalfa seed production has undergone a tremendous increase in the last five years and North America now produces enough for domestic demands, making us independent of seed formerly imported from South America (chiefly Argentina), Arabia, and South Africa. Such seed distributed in the Corn Belt and Northern States during the past few years caused tremendous losses due to its lack of winter hardihood and susceptibility to disease.

Red-clover seed is grown chiefly in the United States in Ohio, Indiana, Michigan, Wisconsin, Illinois, Iowa, Montana, and Idaho. The production of specially adapted strains such as the Tennessee anthracnose resistant strain, is on the increase and seed-clover production may become of greater local importance in the more southern clover-growing states. There is a trend also toward the development of new areas in the North and Northwest, in clover-seed production, since these regions are free of the noxious weeds now common in most of the older clover seed-growing sections. Large amounts of clover seed are imported from Europe, but imported seed is not as satisfactory as domestic seed.

Alsike clover seed is imported from Canada in large amounts and is produced in the United States in Indiana, Michigan, New York, Wisconsin, and Idaho. The encroachment of night-flowering catchfly (which has seed very similar in size and appearance to alsike seed) is driving profitable alsike-seed pro-

duction out of many of the established areas in Michigan and other states. **White clover seed** is produced in Idaho, Wisconsin, and Louisiana. **Ladino clover seed** is grown chiefly in Idaho.

Crimson clover seed is imported in quantity and is also produced in Delaware, Maryland, Virginia, and the Carolinas.

Winter vetch seed is largely imported from Russia, though Michigan and neighboring states produce a comparatively small amount of high quality seed. The increased use of vetch as a cover and winter pasture crop in the South is at present stimulating domestic production of seed. **Spring vetch seed** is largely produced in Oregon.

Canada field Peas are limited in production to Michigan, Wisconsin, Minnesota, Idaho, Washington, and the southern Canadian provinces.

Soybeans are now being grown for seed throughout the soybean growing region, which almost coincides with the corn region, extending somewhat further south and not quite so far to the north. Varieties are of comparatively local adaptation and now that the period of introduction is passed in many territories, soybean seed is being more largely handled by farmers for their own consumption. The production of cowpea seed is confined to the South.

The Grasses are grown over a wide territory and as a rule produce seed wherever they thrive. The production of the seed of various grasses is, however, limited to quite definite areas, due chiefly to custom and the development of skill in handling for seed and facilities for cleaning and marketing in these districts.

Timothy seed is produced practically throughout the northeast quarter of the United States, but Iowa, Illinois, Missouri, Minnesota, Ohio, Kansas, the Dakotas, and Wisconsin are the states of leading excess production. The United States produces an excess of timothy seed and exports a considerable amount. This grass is an excellent seed producer and seed is generally cheap and plentiful.

Red top seed is produced almost entirely in southern Illinois, **Orchard grass** in northern Kentucky and southern Indiana in greatest quantity. **Kentucky bluegrass seed** is mostly produced in the Bluegrass region of Kentucky with increasing amounts coming from Missouri and Iowa. **Canada bluegrass seed** comes from Ontario.

Meadow fescue is grown for seed in eastern Kansas. **Smooth bromegrass** produces seed best in the Dakotas, Idaho, Washington, and Oregon. The seed of **Sudan grass** is produced chiefly in Kansas, Nebraska, Texas, and Oklahoma. **Johnsongrass** seed is grown in Texas, Louisiana, and Mississippi.

Of the **millets,** Golden and Common millet seed is chiefly grown in Kansas, Nebraska, Iowa, Missouri, and Illinois. The Japanese millet seed is chiefly produced in Iowa, Nebraska, and New York; Broom corn or Hog millet in Colorado, South Dakota, and North Dakota. In time of scarcity, the production of millet seeds extends to many other states.

The grain sorghums are chiefly grown for seed in western Kansas, western Oklahoma, and western Texas and eastern Colorado. Amber sorghum seed for forage purposes is grown in Kansas, Nebraska, Oklahoma, Texas, Iowa, and Missouri.

Dwarf broomcorn seed is grown in Kansas and Oklahoma, and the **Standard** or large type in Illionis.

FIBER CROP SEED PRODUCTION

Cotton seed is produced throughout the cotton-growing region of the South. There is seldom a shortage of seed for planting, farmers reserving their own seed to a large extent and growers carrying over an excess supply as a rule. Recently the development of superior strains has met with an increased demand for select seed stocks.

Hemp seed production is localized along the Kentucky River in Kentucky. The imported hemp seed from China and Japan is used for feeding poultry and tame birds. It is worthless for fiber purposes and since the seed is similar in appearance

to Kentucky-produced hemp seed, it is highly important that hemp seed be secured from reliable sources.

Fiber flax seed is grown chiefly in Ontario and Michigan where comparatively small acreages of fiber flax are grown.

MISCELLANEOUS FIELD CROP SEEDS

Flax seed, used chiefly in making linseed oil, is grown in North and South Dakota, Montana, Minnesota, and in Manitoba and Saskatchewan. The seed used in planting the crop is produced throughout the flax-growing area. The seed of wilt-resistant strains is in strongest demand.

Sugar-beet seed is largely imported from Germany, Russia, Denmark, and France. During the War, enough seed to plant the larger part of our acreage was produced in the beet-growing states of Colorado, Utah, Michigan, and California. Now that normal trade channels are again open, the great bulk of sugar-beet seed is again imported but seed production is being maintained with selected strains in several of the important sugar-beet states.

Seed potatoes are produced throughout the potato-growing areas, but the central and southern potato-growing states are consuming large quantities of northern-grown certified seed potatoes. The northern-grown seed potatoes are produced under climatic and soil conditions which insure a greater freedom from tuber-carried diseases and they are stored under conditions which keep them in much better condition.

The certified seed potato business is developed chiefly in Maine, New York, Michigan, Wisconsin, Minnesota, Nebraska, the Dakotas, and Idaho.

THE DOMESTIC PRODUCING AREAS OF GARDEN, TRUCK AND CANNING CROP SEEDS

Large quantities of our vegetable seed supplies have been imported since earliest times and at the present time a much greater proportion of vegetable seed is imported than of other crop seeds.

The serious interruption of seed importation during the World War greatly stimulated the domestic production of vegetable seeds and though the return of normal trade conditions caused a resumption to a considerable degree of seed importations from former sources, the domestic production of certain vegetable seeds has been largely maintained.

Sweet-corn seed has, of course, always been produced in

FIG. 191.—Harvesting Crop of Onion Seed on California Ranch of Fosgate & Lion. The heads are placed in bags and carried to drying sheets. They are allowed to dry for two weeks and are then threshed by machine. (Courtesy of Seed World.)

this country, the leading states being Iowa, Nebraska, Minnesota, Illinois, Ohio, and Michigan.

Garden and canning peas are grown chiefly in Montana, Idaho, Washington, California, Wisconsin, Michigan, and Ontario. There is a growing demand for selected stocks of improved varieties.

Garden beans are chiefly grown in California, Idaho, Colorado, Michigan, and New York. The white pea bean in Michi-

gan and New York; the Great Northern in Idaho; the Pinto in Colorado and California; the lima bean in California; and the Red Kidney bean in Michigan.

Onion seed is produced in California, Michigan, Ohio, and Connecticut, and onion sets in Illinois (chiefly in Cook County), Colorado, Idaho, Ohio, New York, and Michigan.

Large supplies of seed of the commonly termed "foreign types," such as the Crystal White Wax, Italian varieties, and Bermuda, as well as some of the smaller pickling varities, are imported.

Radish seed, largely imported before the World War, is now grown in quantity in Michigan and California. One county in northwestern Michigan (Antrim) produces over 50 per cent of the radish seed used in the United States.

Cabbage seed, formerly almost wholly imported from Denmark and Holland, is now substantially produced in Long Island (New York), and in the Puget Sound region of Washington. While imported sources remain important, domestic production is increasing rapidly. Though grown in seaside territories, it can also be produced in the cool, moist climate of the Great Lakes region.

Cauliflower seed comes almost entirely from European sources.

Turnip seed is grown in Washington, Oregon, and the New England states. A large amount is imported.

Kale seed is produced in the Gulf states of the South and much is imported.

Spinach seed, formerly entirely of imported sources, Holland, Italy, and Greece, is now largely grown in California, the Pacific Northwest, Michigan, and New York.

Garden beet seed is produced in Oregon, Washington, New York, and Michigan. Foreign sources contribute much of our supply.

Carrot seed is produced in California and the New England states, and is imported in quantity.

Parsnip and celery seed is chiefly grown in California,

though Michigan and eastern Pennsylvania are now producing a small supply of seed of select strains of celery. Quite a lot of French seed is imported.

Asparagus seed is produced in California, New Jersey, and Michigan and small amounts of a special strain in South Carolina.

Rhubarb seed is grown locally throughout the country. Michigan leads in commercial production.

FIG. 192.—Melons Piled Ready for Threshing on Farm of D. H. Gilbert, Monticello, Fla. Note the single row of selected fruits which are reserved for special stock seed. (Courtesy of Seed World.)

Okra seed is produced in Alabama and New Jersey.

The seed of watermelons is produced in Florida, Alabama, Georgia, Oklahoma, Kansas, Colorado, and Michigan.

Muskmelon and cucumber seeds are produced in Colorado, Michigan, Iowa, Ohio, and New Jersey.

Pumpkin and squash seeds are produced in New York, New Jersey, Michigan, Colorado, and California.

Fig. 193.—The "Rocky Ford" Type of Melon as Grown To-day. Much of the musk-melon seed produced in the United States is grown in the Rocky Ford section of the Arkansas river valley, where the soil, climatic conditions and the possibilities of irrigation insure large crops of seed.

Pepper seed is produced in New Jersey and California.

Tomato seed is largely produced wherever tomatoes are an important crop. The Southern States, producing for a northern market, as a rule use northern-grown seed. New York, New Jersey, Maryland, Michigan, Ohio, Indiana, and California grow the bulk of the commercial tomato seed supply.

Lettuce seed is produced in California with the exception of the occasional production of special small supplies of selected strains in Ohio, New York, and Michigan. A small amount is imported.

APPENDIX

CHARACTERISTICS OF VEGETABLE SEEDS

The figures in the following table are intended to be approximate only, as variations occur in varieties and are also due to conditions of growth, harvest and storage.

Vegetable	Average germination one-year-old seed, per cent	Average duration of germinating power in years	Average number of seeds per ounce	Average weight of quart of seed in ounces	Amount required for 100 feet of drill	Amount of seed required per acre	Depth of planting, inch
Asparagus	90	3	1,000	32	1 oz.	5 lbs.	1
Beans, Dwarf	90	3	100	30	1 lb.	60 lbs.	1
Beans, Pole	90	3	100	30	½ lb.	30 lbs.	1
Beet, Garden	80	4	1,750	10	1 oz.	6 lbs.	1
Beet, Mangel	80	4	1,200	10	1 oz.	5 lbs.	1
Brussels Sprouts	85	4	6,500	24	¼ oz.	2 oz.	½
Cabbage	85	4	5,000	24	¼ oz.	4 oz.	½
Carrot	75	3	14,000	12	½ oz.	2 lbs.	½
Cauliflower	75	4	14,000	24	¼ oz.	1 oz.	½
Celery	80	3	100,000	16	¼ oz.	4 oz.	⅛
Collards	88	3	4,500	24	¼ oz.	4 oz.	½
Corn, Sweet	85	3	125	23	¼ lb.	12 lbs.	1
Cucumber	85	5	1,000	18	½ oz.	2 lbs.	1
Egg plant	75	4	5,000	18	⅛ oz.	4 oz.	½
Endive	80	5	13,500	12	1 oz.	2 lbs.	½
Kale	85	4	7,500	24	¼ oz.	1 lb.	½
Kohl-rabi	85	3	7,000	24	¼ oz.	1 lb.	½
Leek	80	2	8,000	18	½ oz.	4 lbs.	½
Lettuce	90	6	16,000	14	½ oz.	3 lbs.	½
Melon, Musk	85	5	1,200	12	½ oz.	2 lbs.	1
Melon, Water	85	5	225	16	1 oz.	2 lbs.	1
Mustard	85	3	18,000	30	¼ oz.	1 lb.	¼
Okra	85	1	425	20	2 oz.	8 lbs.	1
Onion	80	2	12,500	16	1 oz.	4 lbs.	½
Parsley	70	1	17,500	12	¼ oz.	3 lbs.	⅛
Parsnip	75	1	2,800	10	½ oz.	3 lbs.	½
Peas	90	3	50–150	30	1 lb.	60 lbs.	1
Pepper	75	2	4,000	16	⅛ oz.	2 oz.	½
Pumpkin	90	4	100	9	½ oz.	4 lbs.	1
Radish	90	4	5,000	24	1 oz.	10 lbs.	½
Salsify	75	1	4,500	12	1 oz.	8 lbs.	½
Spinach	80	3	3,000	14	1 oz.	8 lbs.	1
Squash, Summer	90	4	360	20	½ oz.	4 lbs.	1
Squash, Winter	90	4	125	14	½ oz.	2 lbs.	1
Tomato	85	3	7,500	10	⅛ oz.	1½ oz.	½
Turnip	90	4	10,000	24	½ oz.	1 lb.	¼

From "Seed Buyers' Guide," published by Seed World.

CHARACTERISTICS OF FIELD SEEDS*

Variety	Viability of good seed	Purity of good seed	Average germination, one year old	Average length of vitality, years	Weight of seed per bushel, legal	Weight of seed per bushel, actual	Quantity required per acre	Yield of seed per acre	Number of seeds per pound, average
Alfalfa	97–99	98–99	94	6–8	60	60–63	15–20	300–700	220,000
Bluegrass, Kentucky	70–85	75–85	30–40	1–2	14	14–28	20–30	200–350	2,400,000
Bluegrass, Canada	85	75–85	30–40	1–2	14	14–24	15	200–500	2,400,000
Brome Grass	90–95	98–99	85–90	5	14	12–20	10–14	250–350	137,000
Clover, Alsike	99	99	75	2	60	60–66	8–12	100–300	700,000
Clover, Red	99	99	90	5–6	60	60–63	8–12	100–300	250,000
Clover, White	99	98	75	2	60	60–63	8–12	200–300	700,000
Clover, Crimson	99	99	90	2	60	60–63	12–20	200–300	125,000
Clover, Sweet	95–98	99	90–95	5	.....	.....	20–30	150–400	235,000
Cowpea	90	99	80	2	60	Variable	30–60	900–1800	1800–5100
Fescue, Meadow	95	90	93	2	.....	20–30	10–15	200–300	250,000
Millet, Foxtail (Common, Golden, Hungarian, Siberian)	90	98	88	4	48–50	40–55	25–50	.....	200,000
Orchard Grass	98	97	90	2–3	14	12–22	12–20	140–168	400,000
Rape	95	99	90	6	.....	.....	2–4	600–1000	.....
Redtop	95	95–98	.....	6	14	12–40	10–20	.....	4,135,900
Rye Grass, Perennial	95	98	80	2	.....	10–30	25–35	250–500	336,000
Rye Grass, Italian	95	98	80	2	20	12–24	35–40	500	285,000
Soy-bean	98	99	90	2	60	60	20–30	1000–2400	2144–6388
Timothy	98	98	95	5–6	45	42–50	9–15	225–450	1,170,500
Vetch	95	99	90	3	60	60	40–90	600–720	70,000–80,000

*From "Seed Trade Buyers' Guide."

ANNUAL PRODUCTION, IMPORTS, AND COMMERCIAL CONSUMPTION OF VEGETABLE SEEDS

(Compiled by U. S. Department of Agriculture)

Kind of seed	Production, average			Imports, average				Commercial consumption, average	
	1916	1917–1922	1923	1916	1917–1922	1923	1924	1917	1918–1923
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Beans, Dwarf Snap	15,074,000	18,718,000	28,333,000	.....	.....	.....	.....	15,074,000	18,718,000
Beans, Garden Pole	1,208,000	3,838,000	4,310,000	.....	.....	.....	.....	1,208,000	3,838,000
Beet, Garden	200,000	922,300	652,500	785,807	293,700	335,215	423,057	985,807	1,216,000
Beet, Mangel	.....	184,000	10,000	.....	40,000	125,471	297,684	.....	224,000
Cabbage	217,000	432,000	448,000	277,886	202,800	180,780	209,592	494,886	634,800
Carrot	534,000	893,000	215,000	38,024	35,400	42,431	134,206	572,024	928,400
Cauliflower	.....	.....	.....	8,849	11,790	13,944	13,754	8,849	11,790
Cucumber	920,000	681,000	1,212,000	.....	.....	.....	.....	920,000	681,000
Kale	29,000	25,700	42,700	40,148	31,100	34,875	50,421	69,148	56,800
Kohl-rabi	.....	.....	.....	10,430	13,600	15,960	13,376	10,430	13,600
Lettuce	1,078,000	684,000	380,000	.....	.....	.....	.....	1,078,000	684,000
Muskmelon	277,000	259,000	501,000	.....	.....	.....	.....	277,000	259,000
Watermelon	470,000	793,000	711,000	.....	.....	.....	.....	470,000	793,000
Onion seed	1,329,000	1,150,000	935,000	75,000	85,000	117,541	104,027	1,404,000	1,235,000
Onion sets	22,756,000	33,575,000	23,200,000	.....	.....	.....	.....	22,756,000	33,575,000
Parsley	123,000	76,300	25,000	70,229	104,850	67,883	146,782	193,229	181,150
Parsnip	67,000	106,200	73,000	100,301	38,800	18,547	57,974	167,301	145,000
Peas, Garden	52,014,000	52,694,000	66,300,000	.....	.....	.....	.....	52,014,000	52,694,000
Pepper	17,000	43,600	26,500	14,900	6,690	2,775	3,276	31,900	50,290
Radish	720,000	1,116,000	600,000	309,417	190,000	349,853	651,061	1,029,417	1,306,000
Salsify	32,000	35,300	.....	.....	.....	.....	.....	32,000	35,300
Spinach	45,000	460,000	197,000	838,235	1,059,000	2,016,890	2,685,972	883,235	1,519,000
Squash, Summer	164,000	145,000	115,500	.....	.....	.....	.....	164,000	145,000
Squash, Winter	87,000	189,700	182,000	.....	.....	.....	.....	87,000	189,700
Sweet Corn	8,468,000	9,864,000	8,825,000	.....	.....	.....	.....	8,468,000	9,864,000
Tomato	187,000	221,000	150,000	.....	.....	.....	.....	187,000	221,000
Turnip and Rutabaga	23,800	166,700	243,000	1,816,055	1,679,330	928,770	1,550,653	1,839,855	1,846,000

FORAGE PLANT SEEDS PERMITTED ENTRY INTO THE UNITED STATES UNDER THE SEED IMPORTATION ACT

By fiscal years and by countries exporting

Reported by the Seed Testing Laboratory, Bureau of Plant Industry, U. S. Department of Agriculture*

Kind of seed		Argentina	Canada	Chile	China	Czecho-Slovakia	Denmark	England	France	Germany	Holland	Ireland
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Alfalfa	1919		34,300					54,700	143,300			
	1920	2,439,300	10,800	27,000				1,139,700	1,546,800	59,200		
	1921	385,800	1,700					17,900	278,800			
	1922	6,555,300	44,800	44,800				35,700	33,200	71,300		
	1923	7,751,600	3,600					a573,600		116,500		
	1924	7,133,200	960,000					21,400	2,905,700	217,300		
	1925	1,037,900	1,689,600						886,200	50,200		
	1926	221,700	4,218,800									
Canada Bluegrass	1919		738,700									
	1920		552,000									
	1921		1,148,200									
	1922		1,034,100									
	1923		835,700									
	1924		816,900									
	1925		1,149,700									
	1926		283,700									
Alsike Clover	1919		6,964,200									
	1920		5,572,600							55,000		
	1921		4,086,700							34,500		
	1922		6,796,500			43,800				216,200		
	1923		5,540,900							2,600		
	1924		11,056,000									
	1925		10,304,500				72,000			48,800		
	*1926		10,885,500					12,200		42,300		
Crimson Clover	1919							88,000	1,373,500			
	1920							504,400	8,845,600	454,300		
	1921					44,100		139,800	3,912,800	1,392,500		
	1922					22,100	21,500	40,300	1,306,000	1,993,200		
	1923					50,000		437,200	1,614,300	62,100		
	1924					416,700		43,600	5,218,300	989,600		
	1925							4,000	4,339,500	82,800		
	1926							82,800	4,955,900	76,000		

*Courtesy of Mr. Edgar Brown, Seed Testing Laboratory, U. S. D. A.

Kind of seed		Italy	Japan	Latvia	Morocco	New Zealand	Scotland	Siberia	South Africa	Sweden	Turkey	Uruguay	Other Countries
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Alfafa	1919	385,500						[a]152,600					
	1920	9,151,900						[a]3,569,900	165,200				721,300
	1921	228,800											28,600
	1922								274,200				22,000
	1923										[a]173,700	164,500	500
	1924	113,200							1,328,000				139,000
	1925	499,400							508,500				[e]110,700
	1926			107,300									500
Canada Bluegrass	1919												
	1920												
	1921												
	1922												
	1923												
	1924												
	1925												
	1926												
Alsike Clover	1919												67,600
	1920												20,100
	1921												
	1922												
	1923												22,600
	1924												
	1925												
	1926												[d]49,400
Crimson Clover	1919	22,000											
	1920	164,300											84,800
	1921	22,000											54,700
	1922												59,800
	1923												98,600
	1924												[b]1,076,300
	1925												407,700
	1926	21,600											[e]629,200

[a] Of Turkestan origin.
[b] 376,700 pounds from Austria, and 495,500 pounds from Hungary.
[d] From Poland.
[e] From Hungary.

FORAGE PLANT SEEDS PERMITTED ENTRY INTO THE UNITED STATES UNDER THE SEED IMPORTATION ACT—*Continued*

Kind of seed		Argentina	Canada	Chile	China	Czecho-Slovakia	Denmark	England	France	Germany	Holland	Ireland
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
	1919		754,200					56,000	83,500			
	1920		98,300					1,786,000	9,253,200	195,300		
	1921		279,900	79,500		132,000		209,400	15,224,600	44,000		
Red	1922	16,800	449,200	670,800		374,100			2,947,800	2,851,600		
Clover	1923		5,100	12,200				44,800	169,800	84,000		
	1924		333,100	778,700		264,700		[c]3,999,000	17,610,300	126,200		
	1925		151,900	232,600		45,300		[g]281,100	4,932,600	432,600		
	1926		288,000	85,200				100	18,889,600	389,900	11,000	
	1919											
	1920					77,000		11,200		19,800		
	1921					82,800	39,600			326,200		
White	1922					125,000	93,300	50,100		1,138,800		
Clover	1923					35,400	55,000	72,600	11,500	174,300		
	1924					75,000	59,400	581,800	34,100	320,000		
	1925		1,300			197,000	14,200	35,400		661,600	22,000	2,200
	1926		100			88,000	5,500	114,300	7,700	743,100	44,400	
	1919											
	1920											
	1921							151,200	1,100			
Broomcorn	1922				738,200					233,400		
Millet	1923				3,110,600			114,100		44,300		
	1924				467,500							
	1925				31,100							
	1926											
	1919		200				99,500					
	1920						2,309,300			114,000		
	1921											
Orchard	1922						2,533,200			339,500		
Grass	1923		11,200				733,900			21,900		
	1924		1,100				476,300			125,800		
	1925						935,500			54,400	2,000	
	1926						249,700				3,300	

Kind of seed		Italy	Japan	Latvia	Morocco	New Zealand	Scotland	Siberia	South Africa	Sweden	Turkey	Uruguay	Other Countries
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Red Clover	1919	153,800							3,400				
	1920	7,808,900											126,200
	1921	221,900											142,000
	1922	2,053,800											1,027,100
	1923												132,000
	1924	999,400											617,500
	1925	151,100					154,400						159,800
	1926	33,000					10						28,400
White Clover	1919												700
	1920					78,300							2,700
	1921					22,200							44,700
	1922	800				49,100							165,700
	1923					60,800							110,000
	1924					60,700							276,500
	1925					4,400							*d*289,200
	1926						20						*d*663,300
Broomcorn Millet	1919												
	1920		225,400										
	1921												
	1922		524,400										
	1923		1,068,900		478,400			443,800					100,800
	1924				110,200								17,500
	1925	22,000	149,900										50,000
	1926	72,700	383,500										200
Orchard Grass	1919												77,500
	1920						111,600			235,600			
	1921												
	1922												49,000
	1923												1,000
	1924												200
	1925												
	1926												

c 585,000 pounds was of Chilean origin.
d From Poland.
g All of Chilean origin, except 22,000 pounds.

FORAGE PLANT SEEDS PERMITTED ENTRY INTO THE UNITED STATES UNDER THE SEED IMPORTATION ACT—*Continued*

Kind of seed		Argentina	Canada	Chile	China	Czecho-Slovakia	Denmark	England	France	Germany	Holland	Ireland
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Rape	1919							1,000				
	1920							7,000			189,100	
	1921							153,400	132,000		1,362,600	
	1922							109,300	460,000	33,000	2,981,000	
	1923				425,000			3,000	200,900	22,000	1,100,300	
	1924							1,900	889,000	65,900	4,918,500	
	1925							2,500	234,700	99,500	2,587,300	
	1926							43,400	636,000	735,300	3,043,000	
English Ryegrass	1919							2,900				263,100
	1920						58,800	241,400				1,331,800
	1921						56,400	232,700				1,091,200
	1922						15,200					1,452,700
	1923							11,200				976,000
	1924						2,400	23,900				1,586,600
	1925							49,300		4,400	500	824,900
	1926						2,200	9,100				1,823,700
Italian Ryegrass	1919							2,600				13,400
	1920						228,600	55,000				489,900
	1921						304,600					251,100
	1922	159,800					74,900					344,000
	1923	140,100						1,600				284,100
	1924	100,900					77,200					375,300
	1925	137,100					17,600		338,400		37,200	198,400
	1926	43,100					176,700	37,000	374,600		2,900	972,800
Hairy Vetch	1919		53,900									
	1920		64,500			331,000	78,100			338,000	17,600	
	1921		5,600			66,000	49,200			768,600	3,000	
	1922		80,400			230,600	55,800			1,278,400	20,700	
	1923		7,900			101,400	96,900			1,048,100	30,800	
	1924		700			600,500	47,600			2,221,200	21,200	
	1925					465,600	71,900	32,200		1,036,900		
	1926		70,700			568,600	65,000	35,200		1,982,200	7,000	

Kind of seed		Italy	Japan	Latvia	Morocco	New Zealand	Scotland	Siberia	South Africa	Sweden	Turkey	Uruguay	Other Countries
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Rape	1919	.....	634,800	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,200
	1920	.....	5,569,600	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1921	.....	2,592,100	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,600
	1922	.....	1,114,400	.....	.....	.....	.....	.....	.....	.....	.....	.....	64,900
	1923	.....	4,610,400	.....	.....	.....	.....	.....	.....	.....	.....	.....	22,500
	1924	.....	127,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	597,900
	1925	.....	1,381,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	*d*39,600
	1926	.....	1,406,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	*d*,*e*622,100
English Ryegrass	1919	.....	.....	.....	.....	218,200	346,800	.....	.....	.....	.....	.....	200
	1920	.....	.....	.....	.....	90,900	201,400	.....	.....	.....	.....	.....	33,600
	1921	.....	.....	.....	.....	.....	112,700	.....	.....	.....	.....	.....	30,200
	1922	.....	.....	.....	.....	193,200	133,000	.....	.....	.....	.....	.....	73,600
	1923	.....	.....	.....	.....	648,000	193,600	.....	.....	.....	.....	.....	5,300
	1924	.....	.....	.....	.....	.....	182,600	.....	.....	.....	.....	.....	156,100
	1925	.....	.....	.....	.....	281,600	174,100	.....	.....	.....	.....	.....	100
	1926	.....	.....	.....	.....	210,700	255,900	.....	.....	.....	.....	.....	.....
Italian Ryegrass	1919	.....	.....	.....	.....	169,400	22,400	.....	.....	.....	.....	.....	.....
	1920	.....	.....	.....	.....	159,900	41,800	.....	.....	.....	.....	.....	4,400
	1921	.....	.....	.....	.....	.....	20,100	.....	.....	.....	.....	.....	800
	1922	.....	.....	.....	.....	92,900	63,300	.....	.....	.....	.....	.....	93,400
	1923	.....	.....	.....	.....	262,000	28,900	.....	.....	.....	.....	.....	142,800
	1924	.....	.....	.....	.....	10,100	65,700	.....	.....	.....	.....	.....	406,700
	1925	.....	.....	.....	.....	.....	102,600	.....	.....	.....	.....	.....	.....
	1926	.....	.....	.....	.....	2,300	73,800	.....	.....	.....	.....	.....	.....
Hairy Vetch	1919	.....	.....	168,500	.....	.....	.....	.....	.....	.....	.....	.....	34,100
	1920	.....	.....	.....	.....	.....	27,400	.....	.....	297,600	.....	.....	65,600
	1921	.....	.....	30,500	.....	.....	.....	.....	.....	419,100	.....	.....	44,600
	1922	.....	.....	11,200	.....	.....	.....	.....	.....	138,400	.....	.....	125,400
	1923	.....	.....	172,400	.....	.....	.....	.....	.....	14,500	.....	.....	127,100
	1924	.....	.....	11,400	.....	.....	.....	.....	.....	18,800	.....	.....	293,500
	1925	.....	.....	205,600	.....	.....	.....	.....	.....	.....	.....	.....	*f*256,100
	1926	.....	.....	959,600	.....	.....	.....	.....	.....	76,300	.....	.....	*d*, *e*211,600

d From Poland.
e From Hungary.
f 145,400 pounds from Poland, 109,700 pounds from Hungary.

FORAGE PLANT SEEDS PERMITTED ENTRY INTO THE UNITED STATES UNDER THE SEED IMPORTATION ACT—*Continued*

Kind of seed		Argentina	Canada	Chile	China	Czecho-Slovakia	Denmark	England	France	Germany	Holland	Ireland
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Spring Vetch	1919		435,200							228,000		
	1920		200,400					452,600		343,200	11,000	
	1921		3,600					93,300		334,600		
	1922		100							1,115,200	233,100	
	1923						17,600	35,100		460,400	616,200	
	1924		600							208,800	945,500	
	1920		1,000							479,400	405,400	
	1926		118,000					44,800				
All other forage crop seeds	1919		848,200									
	1920		622,400				2,800					
	1921		860,700							3,300		
	1922		480,700							3,200		
	1923		51,400		65,200		3,100					
	1924		209,400				100			22,000		
	1925		253,400					100		100		
	1926		264,200				2,200	100		15,800	200	

Kind of seed		Italy	Japan	Latvia	Morocco	New Zealand	Scotland	Siberia	South Africa	Sweden	Turkey	Uruguay	Other Countries
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Spring Vetch	1919												
	1920						122,700			11,000			33,600
	1921						44,800						46,500
	1922												9,900
	1923			315,300									141,800
	1924			99,000			800						32,600
	1925			111,000									
	1926			549,700			5,500						
All other forage crop seeds	1919												
	1920												4,100
	1921												1,600
	1922												29,700
	1923						200						11,600
	1924												27,600
	1925												4,900
	1926												*d*10,900

d From Poland.

GENERAL CROP VARIETAL RECOMMENDATIONS BY STATES BASED ON ADAPTATIONS. †

Write your Experiment Station for specific sectional adaptations and other information.

The varieties herewith listed are mostly developed by Experiment Station Plant Breeding work and grown under a plan of inspection and certification by Crop Improvement Associations.

	Corn	Wheat	Oats	Rye	Barley	Soybeans	Potatoes	Alfalfa	Clover	Seed Growers' Associations
New York	For Silage S. West Branch Sweepstakes N. Ohio Grown Leaming Grain and Ensilage North and High Altitude Cornell 11 Golden Glow Early Huron Bailey Dent South and Southeast Leaming Luce's Favorite Hall's Golden Nugget	Forward Dawson's Golden Chaff New York No. 6 (gold coin) Junior No. 6 No 10. Red Rock	Cornellian Jefferson Co. Banner Welcome Wolverine Crown Victory	Heinrich Rosen	Alpha Featherstone Wisconsin Pedigree No. 5 O. A. C. No. 21 Oderbrucker Chevalier	For Silage S. Wilson C. Medium Early Green Elton N. Manchu Ito San For Seed Ito San Wisconsin Black	White Rural Russet Rural Green Mountain Irish Cobbler Early Ohio	Grimm Northwestern Common Ontario Variegated	Northern Grown Domestic	* New York Seed Improvement Cooperative Assn., Inc., Ithaca. * G. L. F. Exchange, Syracuse.
Michigan	S. Laughlin Duncan (M. A. C.) C. Pickett Golden Glow M. A. C. Dent Polar Dent N. Golden Glow N. W. Dent	Red Rock Berkeley Rock American Banner Gold Coin Dawson's Golden Chaff	Wolverine Worthy College Wonder	Rosen	Michigan Two Row Wisconsin Pedigree	Manchu Ito San Early Black	Russet Rural White Rural Green Mountain Irish Cobbler Early Ohio	Hardigan Grimm Cossack Lebeau Ontario Variegated Northwestern Common	Native or Northern Grown Domestic	*Michigan Crop Improvement Association, East Lansing. * Farm Bur. Seed Service, Lansing.

* Members, International Crop Improvement Association.

† From Crop Production and Soil Management by J. F. Cox, John Wiley & Sons, Inc.

GENERAL CROP VARIETAL RECOMMENDATIONS BY STATES BASED ON ADAPTATIONS—*Continued*

	Corn	Wheat	Oats	Rye	Barley	Soybeans	Potatoes	Alfalfa	Clover	Seed Growers' Associations
Wisconsin	S. Wisconsin No. 7 Murdock C. Golden Glow No. 8 Golden Glow No. 12 N. Golden Glow No. 25	Progress Marquis (No. M 1611) Turkey Red Backsa	Wisconsin Wonder (W. P. 1) Swedish Select (W. P. 5) States Pride (W. P. 7) White Cross W. P. 17)	Wisconsin Pedigree Rosen	Wisconsin Pedigree	Wisconsin Early Black Manchu	Green Mountain White Rural Irish Cobbler Early Ohio	Grimm Cossack Northwestern Common	Native or Northern Grown Domestic	*Wisconsin Experiment Association, Madison.
Minnesota	N. Minnesota No. 23 Mercer Flint C. Minnesota No. 13 Rustler S. Murdock Silver King	(Winter) Minhardi (505) Minturki (1507) Crimean 845 (Spring) Marquis 1239 Fife 163 Mindum (Durum 1470)	Victory 514 Imp. Ligowa 281 Iowa 103 Minota 512	Swedish No. 2 Rosen	Imp. Manchuria Minsturdi No. 439	Minsoy 139 Chestnut 110 Habaro	Green Mountain White Rural Early Ohio Spaulding Rose Bliss Triumph	Grimm Cossack	Native or Northern Domestic	*Minnesota Crop Imp. Association, St. Paul
N. Dakota	N. W. Dent Rustler's	Kota Marquis Durum Varieties	Victory Big Four	Dakold	Oderbrucker Manchuria		White Rural Triumph Early Ohio Irish Cobbler	Grimm Cossack	Native or Northern Grown Domestic	Kota Seed Distributing Association, Fargo, N. D.
S. Dakota	Rustler's Minnesota No. 13 Early Reid's Southeastern Wimples, Y. D.	Marquis (s) Kubanka Preston	Cole Victory Big Four	Dakold Rosen	Ace Oderbrucker Manchuria		White Rural BlissTriumph Irish Cobbler Early Ohio	Cossack Grimm S. Dakota Common	Native or Northern Grown Domestic	*S. Dakota Crop Improvement Association, Brookings.

* Members, International Crop Improvement Association.

GENERAL CROP VARIETAL RECOMMENDATIONS BY STATES BASED ON ADAPTATIONS—*Continued*

	Corn	Wheat	Oats	Rye	Barley	Soybeans	Potatoes	Alfalfa	Clover	Seed Growers' Associations
Montana	N. W. Dent Minnesota No. 13 Gehu Flint Rustler's W. D.	Marquis (s) Turkey Pelliss Durum Karmont	Victory Big Four 60 Day	Dakold Rosen	Hannchen Trebi		Burbank Green Mountain Brown Beauty Triumph, Early Ohio	Grimm Cossack Montana Common	Native or Northern Grown Domestic	*Montana Seed Growers' Association, Bozeman.
Oregon	Minnesota No. 13 Golden Glow McKay Reid Y.D.	Turkey Red Hybrid 128 Federation Hard-Federation	Gray Winter Victory Three Grain Markton	Rosen Advance	O.A.C. No. 7 Hannchen Trebi Union Beardless		Netted Gem Burbank Bliss Triumph Irish Cobbler	Grimm	Native Anthracnose-resistant	
Washington	Thayer Yellow Dent Windus White Dent (for ensilage)	Bluestone Baart Hybrid Marquis	Abundance Markton Victory Banner	Rosen	Blue Beldi Giant Trebi		Burbank Idaho Rural Brown Beauty	Grimm Cossack	Native or Northern Grown Domestic	
Idaho		Dicklow Federation Kanred Marquis	Swedish Select Idamine	Short Bearded Rosen	Trebi		Idaho Rural Burbank Brown Beauty	Grimm Cossack Common	Native or Northern Grown Domestic	Growers Listed by Field Agronomist, Boise, Idaho
Kansas	Reid Y. D. Commercial White Kansas Sunflower Pride of Saline	Kanred Black Hull Harvest Queen Fulcaster Marquis (Spring)	Kanota Burt Red Texas Iowa 103 60 Day	Common Kansas Winter	Common Six Row	Haberlandt Morse Manchurian Medium Yellow Austin	White Rural Irish Cobbler Early Ohio	Kansas Common	Native or Northern Grown Domestic	*Kansas Crop Improvement Association, Manhattan, Kans.
Missouri	Reid Y. D. 90 Day Y. D. Johnson Co. White Boone Co. White	Fulcaster Poole Harvest Queen Fultz	Burt Fulghum Kherson Red Rust Proof Silvermine	Rosen	Wisconsin Pedigree	Virginia Midwest Morse Wilson	White Rural Cobblers Early Ohio	Grimm Northwestern Common Kansas Common	Native or Northern Grown Domestic	*Missouri Corn Growers' Association, Columbia, Mo.

* Members, International Crop Improvement Association.

GENERAL CROP VARIETAL RECOMMENDATIONS BY STATES BASED ON ADAPTATIONS—*Continued*

	Corn	Wheat	Oats	Rye	Barley	Soybeans	Potatoes	Alfalfa	Clover	Seed Growers' Associations
Iowa	N. Silver King Iodent C. Iodent Reid Y. D. S. Reid Y. D. McCulloch'sY.D.	N. Turkey Red Velvet Chaff C. Kanred S. Kanred	Iowar Iogren Iowa 103	Rosen	Wisconsin Pedigree	Manchu Midwest Ito San Black Eyebrow	Green Mountain White Rural Burbank Early Ohio	Grimm Cossack Northwestern Common	Native or Northern Grown Domestic	*Iowa Corn and Small Grain Growers' Association, Ames, Iowa. *Iowa Crop Improvement Association, Ames, Iowa.
Illinois	N. Murdock's Y. D. Funk's 90 Day Reid Y. D. C. Boone Co. White Reid Y. D. Leaming S. Reid Y. D. Boone Co. White Leaming Funk's 90 Day	Turkey Red Fultz Mediterranean Illinois Chief Fulcaster	Big Four Iowa 103 Silvermine 60 Day	Rosen	Wisconsin Pedigree	N. Early Ito San, A. K. Wisconsin Black C. Midwest A. K. Manchu S. Mongol Virginia	Early Ohio White Rural Russet Rural Irish Cobbler	Grimm Cossack Northwestern Common	Native or Northern Grown Domestic	*Illinois Corn Growers' Association, Urbana, Ill.
Indiana	N. Early Reid's Y. D. Early Yellow Dent Silvermine C. Reid's Y. D. Boone Co. White Early J. C. W. S. Reid's Y. D. Johnson Co. White Boone Co. White	N. Mich. Amber Michikoff Trumbull Gladden S. Purkoff Fultz Poole Rudy	Early Iowa 103 Gopher Fulghum Burt Medium Minota Big 4 Wolverine Victory	Mammoth Winter Petkus Rosen	Manchuria Wisconsin Pedigree Success Beardless	N. Manchu Ito San S. Dunfield Manchu Midwest	Russet Rural White Rural Irish Cobbler Early Ohio	Grimm Cossack Ontario Variegated Northwestern Common	Native or Northern Grown Domestic	*Indiana Corn Association, Lafayette, Ind.
Ohio	N. Silver King Clarage C. Woodburn's Leaming Reid's Y. D. S. Reid's Y. D. Boone Co. White	Trumbull Gladden Poole Fulhio Portage Ohio 9920	Big Four Fulghum Miami Ohio 5222 Ohio 201	Rosen	Wisconsin Pedigree Oderbrucker	Manchu Midwest Wilson Peking	Russet Rural White Rural Early Ohio Irish Cobbler	Grimm Cossack Northwestern Common	Native or Northern Grown Domestic	*Ohio Seed Improvement Ass'n, Columbus, Ohio.
Penna.	*For Grain* N. N. W. Dent Early Huron C. Clarage Wisconsin No. 7 Murdock	Fulcaster Fultz Mediterranean	Big Four Banner Victory Wolverine	Rosen	Oderbrucker Wisconsin Pedigree Charlottetown No. 80	Manchu Wilson	Russet Rural White Rural Green Mountain Irish Cobbler	Grimm Northwestern Common	Native or Northern Grown Domestic	Farm Bureau, Seed Department.

* Members, International Crop Improvement Association.

GENERAL CROP VARIETAL RECOMMENDATIONS BY STATES BASED ON ADAPTATIONS—*Continued*

	Corn	Wheat	Oats	Rye	Barley	Soybeans	Potatoes	Alfalfa	Clover	Seed Growers' Associations
Penna. (Cont'd)	*Grain or Ensilage* S. Clouds Y. D. Greene Co. Y. D. Landis White Cap Boone Co. White *For Ensilage* N. Sweepstakes Reid's Y. D. C. Lancaster Sure Crop West Branch W. C. Reid's Y. D.									
Virginia	Boone Co. White Reid's Y. D. Leaming Cocke's Prolific Eureka	V. P. I. No. 131	V. P. I. No. 1	Abruzzi	Tennessee Winter Union Winter	Virginian Wilson Heel Black Hollybrook Laredo	Irish Cobbler Early Ohio Rurals	Northwestern Common Grimm	Native or Northern Grown Domestic	*Virginia Crop. Imp. Association, Blacksburg.
Kentucky	Boone Co. White Reid's Y. D. St. Charles White	Fultz Fulhio Fulcaster Poole Red Rock Michigan amber	Spring Red Rust Proof Fall Fulghum 60 Day Burt	Rosen Native White	Tennessee Winter Union Winter	Lexington Midwest Haberland Virginia Peking Mammoth Yellow	Early Ohio Irish Cobbler Bull Moose Burbank	Northwestern Common Grimm	Native or Northern Grown Domestic	
Arkansas	Cocke's Prolific Delta Prolific Hildreth Y. D. Sureropper	Red May Fultz Fulcaster Mediterranean	Appler Fulghum Ferguson Winterturf	Abruzzi			Irish Cobbler Early Ohio Triumph Rurals			*Arkansas Seed Growers' Association, Fayetteville,
Nebraska	Hildreth St. Charles White	Turkey Marquis	Neb No 21 Burt Kherson				Triumph Russet Rural White Rural Early Ohio	Native Common		Nebraska Crop Imp. Association, Lincoln.

* Members, International Crop Improvement Association.

General Crop Varietal Recommendations by States Based on Adaptations—*Continued*

Write your Experiment Station for specific sectional adaptations and other information

	Corn	Wheat	Oats	Barley	Soybeans	Potatoes	Alfalfa	Clover
New England States	*For Grain* Early Flint Longfellow King Philip *For Ensilage* Hall's Golden Nugget Sweepstakes Luce's Favorite	Goldcoin	Silvermine Swedish Select Victory	Oderbrucker Wisconsin Ped. Featherstone Alpha	*For Ensilage* Manchu Ito San	White Rural Green Mountain Russet Rural Irish Cobblers Early Ohio Spaulding No. 4	Grimm Ontario Variegated Lebeau	Northern-grown Domestic
Delaware New Jersey Maryland	Leaming Reid's	Currell's Prolific Mammoth Red Selection	Silvermine Swedish Select	(New Jersey) Oderbrucker Maryland Winter	Hollybrook Mammoth Yellow	White Rural Green Mountain Cobblers Early Ohio	Kansas and Northwest Common	Northern-grown Domestic

Recommended Crop Varieties for Canadian Provinces *

(Department of Agriculture, Ottawa)

Provinces	Wheat	Oats	Barley
Maritime	(Spring) Early Red Fife Ottawa 16 Huron Ottawa 3 (Marquis Ottawa 15)	Banner Ottawa 49 Gold Rain Victory (Liberty Ottawa 480, hull-less)	Charlottetown 80 Chinese Ottawa
Quebec	(Spring) Early Red Fife Ottawa 16 Huron Ottawa 3 Marquis Ottawa 15 Ruby Ottawa 623 (Prelude Ottawa 135)	Alaska (very early) Banner Ottawa 49 Gold Rain Victory (Liberty Ottawa 480, hull-less)	Chinese Ottawa 60 O. A. C. No. 21 (Charlottetown No. 80)
Ontario	(Winter) Dawson's Golden Chaff Egyptian Amber (Spring) Early Red Fife Ottawa 16 Huron Ottawa 3 Marquis Ottawa 15 Ruby Ottawa 623 (Goose, Kubanka Ottawa 37)	Alaska (very early) Banner Ottawa 49 Gold Rain O. A. C. No. 72 Victory (Liberty Ottawa 480, hull-less)	Chinese Ottawa 60 O. A. C. No. 21 (Charlottetown No. 80)
Manitoba	(Spring) Marquis Ottawa 15 Red Fife Ottawa 17 Ruby Ottawa 623 (Kubanka Ottawa 37, Prelude Ottawa 135)	Alaska (very early) Banner Ottawa 49 Gold Rain O. A. C. No. 72 Victory (Liberty Ottawa 480 (Hull-less)	Chinese Ottawa 60 O. A. C. No. 21 (Himalayan Ottawa 59, hull-less)
Saskatchewan	(Spring) Early Red Fife Ottawa 16 Marquis Ottawa 15 Red Fife Ottawa 17 Ruby Ottawa 623 (Kubanka Ottawa 37 Prelude Ottawa 135)	Alaska (very early) Banner Ottawa 49 Gold Rain Victory (Liberty Ottawa 480, hull-less)	Chinese Ottawa 60 O. A. C. No. 21 (AlbertOttawa 54, very early) Charlottetown No. 80 late, Himalayan Ottawa 59, hull-less
Alberta	(Winter) Kharkov Turkey Red (Spring) Early Red Fife Ottawa 16 Huron Ottawa 3 Marquis Ottawa 15 Red Fife Ottawa 17 Ruby Ottawa 623 (Kubanka Ottawa 37, Prelude Ottawa 135)	Alaska (very early) Banner Ottawa 49 Gold Rain Victory (Liberty Ottawa 480, hull-less)	Chinese Ottawa 60 O. A. C. No. 21 (Albert Ottawa, 54 very early) Charlottetown No. 80 late, (Himalayan Ottawa 59, hull-less)

* Seed of most varieties available from Canadian Seed Growers, Inc., Ottawa, Canada.

RECOMMENDED CROP VARIETIES FOR CANADIAN PROVINCES.—*Continued*

Provinces	Wheat	Oats	Barley
British Columbia..	(Winter) Dawson's Golden Chaff Egyptian Amber Kharkov Turkey Red (Spring) Early Red Fife Ottawa 16 Huron Ottawa 3 Marquis Ottawa 15 Red Fife Ottawa 17 Ruby Ottawa 623 (Kubanka Ottawa 37, Prelude Ottawa 135)	Alaska (very early) Banner Ottawa 49 Gold Rain Victory (Liberty Ottawa 480, hull-less)	Charlottetown No. 80 Chinese Ottawa 60 O. A. C. No. 21 (Albert Ottawa 54, very early, Himalayan Ottawa 59, hull-less)

COPPER CARBONATE PREVENTS STINKING SMUT [1]

Bunt, or stinking smut, of wheat causes millions of dollars' loss each year because of reduced yields and discounts at the market. This loss can easily be prevented by treating the seed with copper-carbonate dust.

ADVANTAGES OF COPPER CARBONATE

(1) It is a dry treatment and easy to apply.

(2) It is cheap.

(3) It does not injure the seed.

(4) Treated seed can be handled, stored, or planted in the same way as untreated seed.

DIRECTIONS FOR USE

Use 2 ounces of copper carbonate to each bushel of wheat. Under certain conditions $2\frac{1}{2}$ ounces may be used to advantage.

The copper carbonate must be thoroughly spread over each seed. This can be done by thoroughly mixing or stirring the grain and the copper-carbonate dust together. See page 68 for photograph of simple homemade mixing machine.

Wheat treated with copper carbonate usually runs with greater difficulty through the drill. Regulate drill accordingly.

[1] From U. S. Dept. of Agric., B. P. I.

Treated seed should not be allowed to become wet or to stand in the seeding machine if moist.

Warning

(1) Copper is poisonous.

(2) Wear a mask over the nose and mouth when treating grain with copper-carbonate dust. The dust causes irritation, nausea, and sickness if inhaled. In so far as possible, the treating should be done in the open or in a well-ventilated place.

(3) Do not treat wheat except for sowing. After seed wheat has been treated do not use it for food or feeding purposes. Bread made from treated wheat is not fit to eat, even if the treated grain is scoured before milling.

THE FORMALDEHYDE TREATMENT FOR STINKING SMUT OF WHEAT, COVERED SMUT OF BARLEY, AND LOOSE SMUT OF OATS [2]

Sprinkling Method

Mix 1 pint of fresh formaldehyde with 40 gallons of water. Clean a place on the barn floor and sprinkle with this solution. Spread the grain in a thin layer (4 inches) and sprinkle with the dilute solution of the formaldehyde. Shovel over and over until every kernel is moist. Add layer after layer, sprinkling as before. Two quarts of solution is enough to allow to a bushel. When all the grain is moistened, shovel into a compact heap, cover two hours with a blanket or canvas, then spread out to dry and air. Do not let the wet grain freeze, mould or sprout.

The grain may be planted as soon as it is dry enough to run through the drill. Make allowance for the slightly swollen condition when planting. One pint of formaldehyde will treat from 50 to 60 bushels.

The treatment may be modified by dipping the grain, $\frac{1}{2}$ to 1 bushel at a time, in a barrel or tub of the dilute solutiou. Drain, cover for two hours, dry and the grain is ready for planting.

[2] Dr. G. H. Coons, Botany Dept., Mich. Exp. Sta.

Concentrated Formaldehyde Method

(For stinking smut of wheat and loose smut of wheat)

The convenience of this method is its chief advantage. Only those who will follow directions carefully should employ it since considerable loss may occur as a resulted of improper handling.

Apply formaldehyde, full strength, with hand sprayer while the grain is being shoveled over and over. Use at the rate of 1 pint to 50 bushels, ½ pint to 25 bushels, ⅕ pint to 10 bushels, etc. A dose is a dose—this is as strong as formaldehyde can safely be used on wheat.

Cover the grain 4 hours—absolutely no longer. Then spread to air in a warm, dry place for an hour or two. It is unsafe to leave grain covered or sacked over night. Formaldehyde cannot be thoroughly aired out of grain. **Therefore plant at once.** Treat no more grain than can be sown the same day.

HOT-WATER TREATMENT FOR LOOSE SMUT OF WHEAT [3]

Life History of the Loose Smut

This disease appears at about the time the wheat heads out. The wheat head appears as a mass of black smut spores instead of the normal head. This differs from the "stinking smut" or "Bunt" of wheat in that the entire head is a mass of smut, whereas the stinking smut only affects the individual kernels.

When the wheat heads begin to blossom, that is, when pollinzation takes place, the loose smut spores are blown to the blossoms. Here they germinate and the young smut threads or hyphae grow with the developing wheat kernel so that when an infected kernel reaches maturity the smut is within the kernel itself. When the infected wheat kernel is planted in the fall the smut grows with the young wheat plant as though it were a part of the plant. It continues to grow as a part of the wheat plant and at no time can such smut-infested plant be distin-

[3] G. W. Putnam, Mich. Exp. Sta.

guished from a normal plant until it develops the smut head instead of the normal wheat head. The infected wheat plant seems to lose some of its vigor and because of this when winter killing is prevalent, these smut-infested plants are the first to be killed.

At harvest time the presence of this smut in the wheat can be detected only by the fact that the straws which bore the smut head appear as though the wheat kernels had all been washed off and only the naked straw is left. These are usually in clumps of from three to five representing the straws of an entire plant. This smut does not injure the milling quality of wheat as does the stinking smut.

Treatment

The use of disinfectants such as formaldehyde or copper sulphate is hot effective in controlling this disease because the smut is present within the kernel itself rather than as a spore adhering to the wheat kernel, as is the case in " stinking smut " of wheat.

Treatment then must be to kill the fungus occurring as a part of the wheat kernel. Heat has been found to be the only effective treatment. The following outline presents in a brief manner the method followed in the hot-water treatment for the loose-smut of wheat.

1. Soak wheat from four to six hours in cold to lukewarm water.
2. Dip for one minute in water at 120° F.
3. Soak for ten minutes in water at 129° F.
4. Dip for one minute in cold water.
5. Spread not over 2 inches thick on clean canvas or floor to dry.

Equipment

1. A source of live steam.
2. Three barrels or similar containers.

3. Water.
4. Floating dairy thermometer that will register 129° F.
5. Gunny sacks or screen baskets.
6. Clean canvas or floor.

A source of steam can usually be obtained at the local creamery or by use of the special apparatus herein described.

If steam is to be obtained from the local creamery then usually the wash vats are used for water containers. If the milk can is used for generating steam on the farm, barrels are convenient.

In heating the water by steam, care must be used to have the steam under control by means of a valve or similar arrangement. Open porous gunny sacks tied loosely permit uniform heating of the wheat.

Cautions

1. Fill the milk can entirely full of water before starting the fire under it.

2. Be sure and have only one hose with a valve connection. Leave the other hose open all the time " to avoid blowing up." Adjust the temperature in barrel No. 2 by taking this open hose out or putting it in as the case may be. It will speed up operations to put both in No. 3 at the start.

3. Leave the hose with valve connection in barrel No. 3 so as to give accurate adjustment of temperature in this barrel.

4. A 5-gallon milk can will generate steam for about three hours on one filling with water. To refill remove can from fire and always fill entirely full, to avoid melting of solder, before setting back on fire.

5. Drain sacks on drain boards between barrels.

6. Be sure and spread grain thinly to dry.

7. Have the grain soaked in barrel No. 1 ready to treat before heating up barrels No. 2 and 3.

8. Follow instructions on length of treatment and temperatures to use.

9. You can injure germination by treating too long or by allowing temperature to get above 130° F. Temperatures below 126° are not effective.

SEED TREATMENT

Control of Scab and Black Scurf of Potatoes[4] (Rhizoctonia)

Seed potatoes should be carefully graded, and all ill-shaped, mechanically injured, and partially rotted tubers should be removed before the seed is put in the disinfecting solution. Potatoes should be comparatively free from dirt before they are treated.

Potatoes should be treated while they are dormant and before they are cut.

Soak the potatoes for thirty minutes in a solution of corrosive sublimate (bichloride of mercury), the strength of which is 4 ounces of corrosive sublimate to 30 gallons of water.

Dissolve the 4 ounces of corrosive sublimate crystals in 2 quarts or so of hot water, and then add it to the 30 gallons of unheated water.

Corrosive sublimate corrodes metals. It should be used in wooden vessels. A 50-gallon wooden barrel is a satisfactory container in which to soak the potatoes. By using two or more barrels, a large quantity of potatoes can be treated in a day.

Where 100 bushels or more of potatoes are to be treated, the work can be done more conveniently if a wooden trough or tank that will hold 8 or 12 potato crates is used. The potatoes in bushel crates are immersed in the corrosive sublimate solution. The tank can be made water-tight by lining it with canvas and giving the canvas a coat or two of asphaltum paint.

The corrosive sublimate solution loses its strength with use, because the potatoes and dirt condense the chemical and take it out of solution. From one-tenth to one-fourth of the corrosive sublimate is removed with each batch of potatoes treated. The

[4] Mich. Special Bul. 125.

treating solution can be kept at the proper strength by adding corrosive sublimate from time to time. If the potatoes are placed in the solution loose and are comparatively free from dirt, add 1 ounce of corrosive sublimate dissolved in 1 quart of hot water for each 30 gallons of liquid after each second batch is treated.

If the potatoes are dirty and are treated in bags, add 1 ounce of corrosive sublimate for each 30 gallons of liquid after each batch is treated. When the treating solution gets very dirty, discard it and make up a fresh solution.

One pound of corrosive sublimate will treat from 30 to 60 bushels of potatoes.

Corrosive sublimate is a deadly internal **Poison.** Do not pour the solution where livestock or poultry can get at it, and do not use treated potatoes for eating purposes.

After the potatoes have been taken out of the solution they should be spread in a cool, shady place and allowed to dry throughly. It is a good plan to soak the bags or crates used for handling the treated seed in the corrosive sublimate solution in order to prevent any possible reinfection.

BORDEAUX MIXTURE, 4–4–50

ADAPTED FROM THE "SPRAY PRACTICE OUTLINE," MICHIGAN SPECIAL BULLETIN 93

Dissolve 4 pounds of copper sulphate (blue vitrol, bluestone) in 2 gallons of hot water; then dilute with water to make 25 gallons or $\frac{1}{2}$ barrel. Do not use an iron or tin vessel for this purpose, as the copper sulphate would destroy it, and, besides this, the iron would spoil the Bordeaux. A wooden pail serves very well for this purpose. Slake 4 pounds of lump lime or unslaked lime, into a thin paste, and add water to make 25 gallons. Pour the slaked lime and the solution of copper-sulphate together into a third barrel, and the Bordeaux is made. It should, however, be strained through a brass wire strainer as it is run into the spraying-tank.

For potato leaf-hopper, one may use 5 pounds of copper-sulphate, and $7\frac{1}{2}$ pounds of lump lime instead of the 4 pounds of each recommended for the standard mixture.

Of course a larger or smaller amount of the Bordeaux can be prepared equally well by maintaining the same proportions. Do not mix the chemicals and then dilute, and do not pour either the copper-sulphate into the lime or the lime into the copper-sulphate, but pour them together into a third container, or dip out alternately from the copper-sulphate barrel and from the lime into the mixing barrel.

CARBON DISULPHIDE FUMIGATION FOR INSECTS INSTORED GRAINS AND SEEDS [5]

All fumigants for insects work best during warm weather. A temperature of 70° F. is desirable, but not necessary. Fumigation might better be postponed when the temperature falls below 50°. Furthermore, seeds and grains must be *dry* if the operation is to be successful—that is, if the insects are to be killed without injuring the viability of the seeds.

First, make sure that the bins or barrels are tight. If they are not tight, spread or tack several thicknesses of newspaper over the inner surfaces, over-lapping so as to close all crevices.

Measure the inside of the bin, counting in the air space above the grain, and for each cubic foot of space enclosed in the entire bin allow a dram of carbon disulphide. In 1 pound (avoirdupois) there are 96 drams, and so 1 pound suffices for about 100 cubic feet of space. If it becomes necessary to fumigate at a temperature lower than that stated, then the dose must be proportionally increased. Moist seeds absorb the gas, and the danger of injuring their germinative power increases with their moisture content.

After the bins are made tight, arrange for covering the top. If wooden covers are lacking, it is possible to place sticks across the top of the bin, and then, by placing newspapers between

[5] Prof. R. H. Pettit, Dept. of Entomology, Mich. Exp. Sta.

blankets, to arrange a satisfactory cover which will confine the gas quite effectively. When all is ready, place some old pans on top of the grain or seeds, pour in the liquid, and close everything tightly. Leave for thirty-six or forty-eight hours, and then open up and air thoroughly, shoveling over the grain so so as to let the gas at the bottom escape.

Do the work in the daytime and keep all fire away, since the gas is extremely explosive if ignited. It is also poisonous if breathed. It kills humans just as readily as it kills insects. Furthermore, the insurance in some companies lapses during the operation.

Pure carbon disulphide costs from 30 to 75 cents per pound when purchased retail at a drug store, but a grade which is just as good for the purpose may be had of the makers in 50-pound drums at 6 and 7 cents a pound.

It can be used to advantage also for killing woodchucks, gophers, and other pests whenever it can be poured into burrows.

Carbon disulphide is an evil-smelling liquid which quickly changes to a gas when poured out at ordinary temperatures. The gas is heavier than air, and it settles down through the seeds penetrating to all air spaces and crevices. It will not kill many eggs, and, therefore, the fumigation, may have to be repeated, it is, however, the most generally used fumigant, because there is really nothing which will take its place without greatly increasing the cost.

THE ONION MAGGOT [6]

(*Phorbis ceparum*)

The onion-maggot is a footless white maggot which tunnels in the roots of onions, both seed and multipliers. The adults of these maggots are flies resembling house-flies, except that they are much smaller, and it happens that the adult flies of the onion-maggots love sweets just as dearly as do other flies. Moreover, it is possible to attract and poison the flies of the

[6] Prof. R. H. Pettit, Mich. Exp. Sta.

onion-maggot before they lay the eggs which normally hatch into the maggots that make all the trouble.

To do this, use about twenty small basins to the acre. Distribute them over the onion field to be protected, placing them on the ground, and keep these pans supplied with a little poisoned syrup from the time that the plants appear above ground until the danger is past. The pans should be covered over with wire screen of a mesh just small enough to prevent bees from getting in, but coarse enough to accommodate these small flies. A $\frac{1}{4}$-inch mesh wire screen does rather nicely. This screen will also make it impossible for poultry and wild birds to drink the syrup.

The poisoned syrup is made by dissolving $\frac{1}{4}$ of an ounce of sodium arsenite or of sodium arsenate in a gallon of hot water, and adding a pint of molasses. The addition of a slice of onion makes the syrup more attractive to the flies.

Do not use arsenate of lead or Paris-green, for this purpose; either one would be useless, since neither is soluble.

ONION THRIPS [7]

(*Thrips tabaci*)

The onion thrips is a tiny insect about $\frac{1}{25}$ of an inch long with wings provided with rows of stiff bristles instead of membranes. These tiny jumping creatures have mouthparts capable of scraping and puncturing soft vegetable tissues, rather than capable of truly chewing or of sucking in the ordinary sense. They peck and puncture and scrape, and then suck up the juices thus liberated.

The one on onions feeds freely on a long list of other plants, including cabbage, cauliflower, tobacco, alfalfa and bluegrass. It passes through the winter on refuse from the fields, and no doubt also under fallen leaves and rubbish. The insects are found also near greenhouses and often spread from greenhouses to the fields.

[7] Prof. R. H. Pettit, Mich. Exp. Sta.

They so scrape and injure the surface of an onion top that it turns white and later wilts and goes down, producing a condition known to the growers as "white blast." They are eminently pests of hot, dry seasons, not thriving under cool or wet conditions. They produce five to six generations a year, requiring from about three weeks to a month for development.

Of this period a part is passed in the egg stage, embedded in the tissue of the leaf, and part of the time is passed underground in a tiny cell. Naturally only the active, immature nymphs and the adult-winged individuals stand any chance of being killed by spray or dust. This quiescent stage lasts several days and during that time the insect is, of course, protected. As a consequence, when a nicotine spray is applied, killing perhaps 95 per cent of all the thrips in sight and seeming to be entirely satisfactory at the time, the field will nevertheless be full of thrips again in less than a week. It will be perfectly apparent that for the reason given it is advisable to put on two applications, a few days apart, in order to get the active individuals with the first application, and then to rely on the second application for the individuals that were either in the egg stage or in the resting stage at the time of the first application.

Now, which shall we use, a spray of nicotine or a dust? We must remember that a spray must be applied under high pressure in order to reach the axils of the leaves and really to wet the insects thoroughly, and a high pressure presupposes a power rig. Now when we grow onions in evenly spaced rows, as we now raise them, the act of dragging a power rig through the field will not appeal to the grower.

A power duster also would leave its mark in an onion field, especially in a muck field, but a good hand duster can be made to do pretty well when the acreage is not too large, without very high pressure. For this reason, when one relies on nicotine treatments, the large-sized hand duster seems to offer certain advantages over other rigs.

The most successful application thus far developed, and the application now in general use, consists of a spray or of a dust

of nicotine. If a spray is to be used, apply at the rate of 1 pint of nicotine-sulphate (40 per cent) to 100 gallons of water, with the addition of 4 pounds of laundry soap. If a dust is preferred apply in the regular way. Two applications should be made six seven or days apart.

THE STRIPED CUCUMBER-BEETLE [8]

(*Diabrotica vittata*)

The striped cucumber-beetle is a small black and yellow-striped beetle that feeds on the leaves of cucumber, canteloupe, and other vines of like nature, attacking them as they come up and continuing to feed on them for weeks.

Not only do the beetles feed on the plants, but they also lay their eggs on the stems, and the grubs from these eggs burrow in the stems and roots.

There are several methods of controlling the beetles, usually by dusting on soot, or hydrated lime or some poison. A satisfactory dusting-powder is prepared by mixing about 2 tablespoonfuls of turpentine into a pailful of air-slaked lime or of hydrated lime. Stir the mixture well and then allow it to stand for a few hours before dusting on the plants. The powder is used by dusting on the leaves, either through a coarse cloth or by means of a mechanical duster, every few days as long as the beetles continue to make trouble.

When the vines are grown on a large scale, the use of nicotine dust has been found to be very satisfactory. Mr. Roy Campbell recommends the use of a dust made of six parts by weight of 40 per cent nicotine sulphate added to 94 parts of hydrated lime and kaolin. He advises as well the addition of ten parts in a hundred of dry-powdered arsenate of lead to the dust so prepared. The dust may be used either with or without the aresenate of lead. It should be applied by vigorous puffs with a hand duster at the rate of 1 pound of dust to two or three

[8] Prof. R. H. Pettit, Dept. of Entomology, Mich. Exp. Sta.

hundred hills of small vines. Later, when the vines get large, the amount applied will naturally have to be increased.

A dusting powder which is very highly recommended by the entomologists of the states south of Michigan and which orginated at the Ohio Experiment Station, being brought out by Professor Gossard and Dr. Dalduf, is made by mixing 1 pound of calcium arsenate with 20 pounds of burned gypsum. It should, of course, be mixed in a mill, or else the two powders should be sifted together many times, so as to insure a perfect combination of the poison with the carrier.

PLANT LICE IN GENERAL[9]

Plant lice are tiny, fragile creatures with bodies easily crushed. These pests depend on their fecundity to replace the individuals lost by constant inroads made on them by natural enemies and by disease. They are almost incapable of escaping disaster by flight, since their movements are so deliberate; at the same time they are serious pests, since they are immune to all of our ordinary stomach poisons used as sprays. Contact sprays and dusts alone prove adequate, and these are all high-priced. Plant-lice suck the juices from plants by means of beaks which penetrate through any surface-coating which may be spread on a plant, and in many instances the making of these feeding punctures is followed by results out of all proportion to the mechanical injury inflicted or to that resulting from the loss of the plant juices. The plant responds just as if some toxin had been injected, leading sometimes to a stimulation of abnormal growth or to a stunting or even to the death of tissue.

Plant lice occur on many plants. Those on most of our garden plants and on shrubs, ornamentals and greenhouse plants may be successfully treated by sprays of nicotine or by dustings with nicotine dusts. Some species are protected by woolly or waxy coats and these are naturally more resistant to sprays than those having naked bodies. The old spray of kerosene-

[9] Prof. R. H. Pettit, Dept. of Entomology, Mich. Exp. Sta.

emulsion is effective enough when used against such woolly species, but it is troublesome to make and is no longer cheap. Nicotine has apparently superseded all the other common sprays, at least in commercial operations.

The standard spray to be used against plant lice living out-of-doors is 40 per cent nicotine-sulphate, and wish few exceptions it is the most economical and safe contact spray to use. It does, however, leave a fairly permanent poisonous residue and is not to be used on such plants as lettuce, spinach or anything having an extensive leaf surface where the leaves are to be eaten. In such cases substitute the straight volatile nicotine, which evaporates, leaving no appreciable residue.

For ordinary sprays, use 1 pint of 40 per cent nicotine-sulphate to 100 gallons of water, with the addition of about 4 pounds of laundry soap unless the nicotine is to be combined with lime-sulphur or with some other chemical that is incompatible with soap, in which case omit the soap. Always remember that each louse must be *hit* to be killed.

Dusts containing nicotine usually, if not always, contain volatile nicotine. As a result, while some dusts liberate the fumes more quickly than do others, the fumes are still similar in all cases. In the case of extensive dusting operations, it is often advisable to drag a trailer of light-weight cloth over the plants to help keep the dust from blowing away too quickly and to retain the fumes for a short time.

FORUMLA FOR POISON BAIT FOR CONTROL OF CUT-WORMS [10]

Mix very thoroughly:

20 pounds bran
½ gallon cheap molasses
A little water
1 pound of white arsenic (not arsenate of lead), or 1 pound of Paris-green and scent with a small amount of amyl acetate (banana oil) or ethyl acetate (acetic ether) and broadcast.

[10] Prof. R. H. Pettit, Mich. Exp. Sta.

This is sufficient for an acre or so of land.

It should be put on in the evening in small particles and allowed to lie on the surface.

Fall plowing of grass sod is destructive to cut-worms. For the climbing species use the poison bait, and in addition place a band of tree-tanglefoot or some similar material about the trunk of the tree. In the case of grape vines, the posts and wires must be similarly treated, of course.

FORMULA FOR CONTROL OF GRASSHOPPER [11]

1 bushel hardwood sawdust
¾ to 1 pound salt
1 pound white arsenic or Paris-green, or best of all 1 pound of arsenite of soda (not arsenate of lead)
3 ounces banana oil (amyl acetate) of a good grade
Water to moisten

Dissolve salt in water. Stir in the arsenic, mix the liquid into the sawdust and add banana oil. Then *mix thoroughly.* Mix once more, and broadcast around the edge of the farm, making a dead-line. Keep this up, using a bushel or so every day just as the hoppers begin to move, at about ten o'clock in the morning, until the crop is harvested or until the danger is past.

SALT SOLUTION METHOD OF SEPARATING ERGOT FROM RYE

Fill tub half full of water, throw in hand-full of rye carrying ergot. Add common salt, stir and allow to go into solution to point where ergot floats and rye sinks (about 20 per cent saturation). Pour in rye seed to be freed of ergot in half peck quantities. Stir and allow rye to settle, skimming off ergot. Drain salt solution into another vessel. Dump rye on floor and spread out thinly to dry. Continue process with lot to be cleaned.

The same method may be used in separating many weed seeds from small lots of seed.

[11] Prof. R. H. Pettit, Mich. Exp. Sta.

THE RAG-DOLL TESTER FOR TESTING GERMINATION OF SEED CORN

Cut cloth (cambric, muslin, or flannel) into strips 5 feet long and 10 inches in width. Bisect lengthwise with heavy pencil line. Beginning about 15 inches from end draw eleven cross lines at right angles to center line, 3 inches apart. Number spaces from one to ten on upper side of line and eleven to twenty on lower side.

Select and number ears to be tested. Dampen cloth and lay out smoothly on table. Remove six kernels from different parts of ear number one and place germ side up in space number one, tips pointing in same direction. Proceed with each ear in like manner. When spaces are filled roll carefully so as not to displace kernels and tie roll around center with string, place each roll as finished in bucket, cover with lukewarm water for several hours. Drain, and cover top with damp cloth or newspaper. Place in warm room. After several days moisten with warm water. On seventh day test is usually ready to read.

To read test unroll cloth carefully on table and study kernels in each square. Discard all ears corresponding to squares showing dead kernels or kernels which produced weak sprouts or mouldy sprouts. Save for planting ears with kernels showing strong, clean, stem and root sprouts.

COMPOSITE TEST

To test germination of shelled corn or to secure approximate condition of ear corn a composite test of 100 kernels should be made. In taking samples of ear corn, extract 100 kernels from each of 100 ears representative of entire lot. Place kernels in rag doll. After seven days count kernels which show strong germination. It will pay to ear test corn of less than 95 per cent germination.

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